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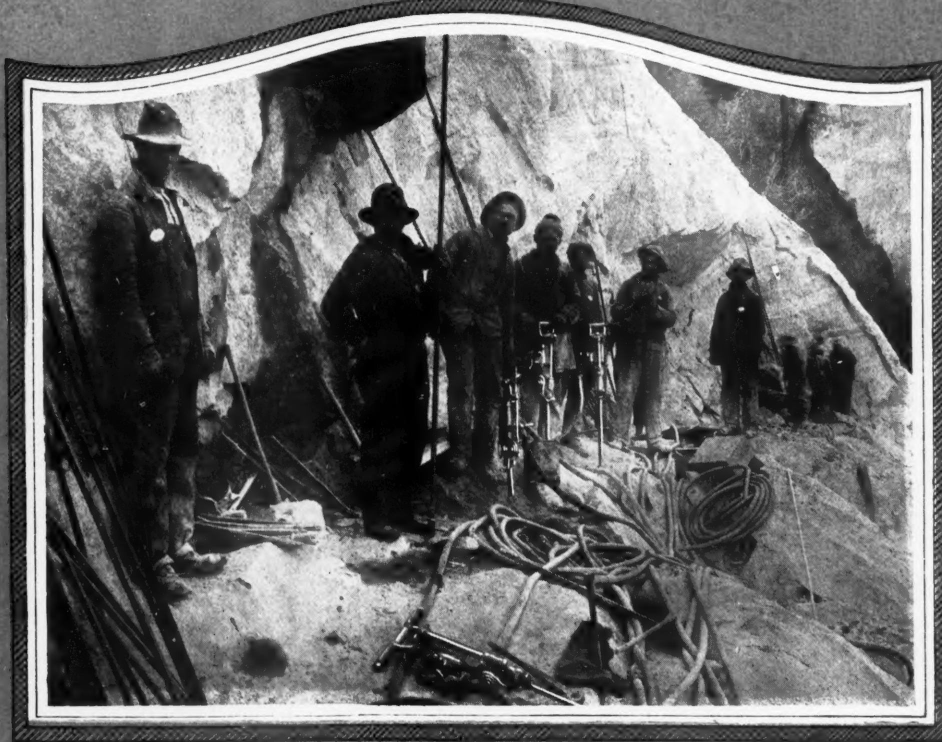

DRIVING FORWARD DESPITE NATURE'S OPPOSITION: DRILLING AND BLASTING A ROADWAY ALONG THE STEEP FACE OF A ROCKY CANYON

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Putting Metals of Fighting Ships to Peacetime Purposes

Many Thousands of Tons of Valuable Materials are Now Being Reclaimed by Demolishing Battle Craft; and This Work is One of Growing Importance

By ROBERT G. SKERRETT

> **THE STORY of secondary metals is largely a tale of amazing economies shown to be practicable under the stress of the World War; and, incidentally, it indicates tremendous savings which can be effected in normal times.**
>
> **Secondary metals are really second-hand metals as distinguished from primary metals derived directly from ores and put to their first uses. Commonly, something like 20,000,000 tons of scrap iron and steel are marketed annually and remelted to be worked again into diversified commodities.**
>
> **Similarly, non-ferrous metals are reclaimed and made fit for re-use; and in the course of a single year the copper, brass, lead, zinc, tin, nickel, etc., so recovered have had a total value of nearly $190,000,000. The breaking up of battle craft and the demolition of merchant ships, not to mention the dismantling of steel and iron structures of many sorts, therefore represent a profitable and a worth-while branch of industry.**

THE PEACEFUL demolition of our erstwhile dreadnoughts, armored cruisers, submarines, and so forth, has brought into being a new group of industrial specialists. This is the outcome of the agreement by which the leading maritime powers decided a while back to limit for a period of years the upbuilding of their battle fleets.

A quarter of a century ago we called the forerunners of this group junkmen, and their position in the business world was somewhat lowly. Today, a goodly number of these men are known to the trade as scrap-metal dealers, and they occupy a not-inconspicuous place in the commercial life of the nation. Probably, in the near future, the more important of this fraternity will be appropriately classified as secondary-metal engineers.

This is not said in a spirit of humor but, instead, to indicate that credit of a distinctive sort must be given to those who handle metal scrap on a notably large scale and who make their wares marketable only after the exercise of much skill and the expenditure of a good deal of work. While there are a number of plants in this country now engaged in breaking up fighting ships that have been scrapped, this article has been inspired primarily by the activities at the yard of Henry A. Hitner's Sons Company, in Philadelphia, Pa. There, on the waterfront of this spacious plant, are crowded together a formidable array of vessels which in their day, and that not so long ago, typified the climax of the naval architect's cunning.

The construction of a battleship is a toilsome undertaking covering a span of 30 or 40 months—depending upon the size of the craft. Plates, angle bars, and beams are assembled laboriously and bound together by the driving of thousands and thousands of rivets. Armor plate, wood backing, deck planking, and hundreds of operative equipment, powerful prime movers, and a formidable list of auxiliaries are secured in their respective places by tons and tons of bolts of various sizes and lengths. Further, there is a perfect maze of metallic arteries for the distribution of water, steam, and compressed air or for the ventilating and the drainage of the scores of subdivisions or separate compartments which constitute the honeycombed interior structure of ships of this kind. Next, as if to simulate on a titanic scale the nervous system of a living organism, there is an interminable network of electrical conductors of different sizes ranging from power cables to the miniature wires of the telephone and automatic alarm systems. Finally, there are ponderous guns and all sorts of facilities which make the battleship fit for the grim task for which she is designed.

These details should help us to grasp something of the staggering task which confronts the shipbreaker in removing the "internals" of a vessel of this character and then in progressively dismantling her hull until her very keel is laid bare. It should be self-evident that these great steel bodies can be converted into scrap metal only by burning or cutting out myriads of rivets, by driving out a seemingly endless number of bolts, and by cutting up metallic features of the quondam battle craft into blocks and sections of such size as can be fed into furnaces for remelting and conversion into other useful forms.

Offhand, the undertaking may seem to be one demanding little if any skill, but this is by no means the case. Care, resourcefulness, and a good deal of engineering knowledge must be displayed; and the execution of the task necessitates the employment of mechanical equipment of a diversified nature. It must be remembered that the aim of the shipbreaker is to dismantle a vessel expeditiously and with the least practicable outlay so that he can dispose of his scrap or secondary metal at a profit. This brief survey of the problem will make it plain why at the Hitner plant we find many of the facilities common to shipbuilding yards and also see there other apparatus which are especially suited to the work in hand.

While powerful shears are utilized in dealing with some of the scrap, still the major part of the cutting and the dismantling is done by pneumatic tools and by the fusing heat of the oxy-acetylene torch. But before detailing the procedure at the Hitner yard, let us consider for

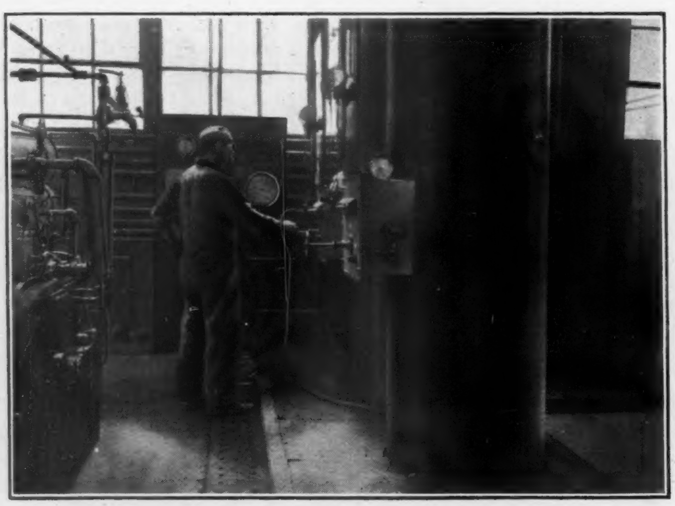
a moment the importance of scrap metal to certain branches of our industrial life. Many millions of dollars worth of copper, lead, brass, bronze, iron, steel, etc., are recovered annually from various sources, assorted, and sold for re-use. Without this scrap metal, a far heavier burden would be laid upon mining activities and a tremendous economic sacrifice would be entailed, because all this scrap represents work at the refinery and the blast furnace that has previously made the raw ore fit for man's service. Some of the steel, for instance, in an armored battleship—that which carries a percentage of nickel—is especially valuable in the manufacture of automobiles or when reforged for different purposes. Similarly, other kinds of scrap are at a premium among metal manufacturers and lighten or shorten the task of turning out commodities of prescribed characters. For example, small steel scrap obtained in breaking up battle craft is sold principally to gray-iron foundries where it is treated in combination with low-grade iron and reappears as framing for harvesting and other agricultural machinery, as engine bases, and in the make-up of iron products of relatively low tensile strength.

The "radiograph," an adaptation of the oxy-acetylene torch, can cut through a 14-inch piece of armor plate at the rate of six feet in twenty minutes.

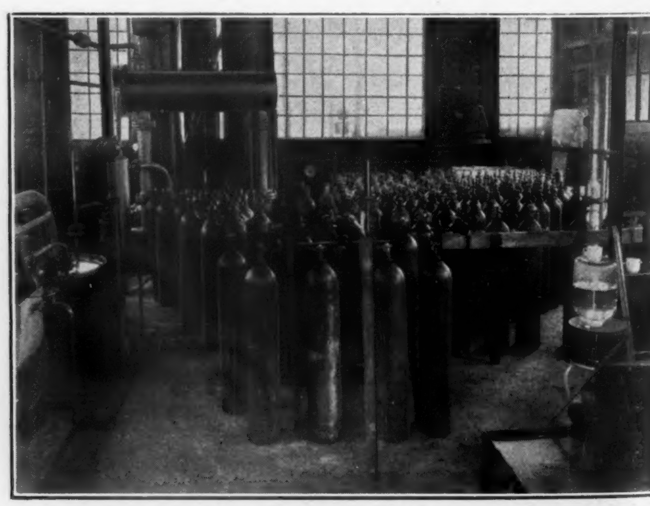
The acetylene manufacturing plant installed at the waterfront of the Hitner yard. This equipment is the source of all the acetylene gas used by the numerous cutting torches.

A ship of 13,500 tons has her weight apportioned as follows: 35 per cent. or 4,725 tons in her steel hull; 26 per cent. or 3,510 tons of heavy hardened plating designed to protect her vitals from the attack of enemy projectiles; and 39 per cent. or 5,265 tons representing propelling machinery, armament, ammunition, equipment, etc. The shipbreaker, after stripping the craft of her comparatively light and easily detached interior fittings, then proceeds to remove her masts, smokestacks, bridges, and superstructure so as to open up yawning chasms in her upper deck to facilitate her disemboweling. Air-driven socket wrenches run off heavy nuts, and pneumatic hammers punch the deck bolts and other bolts out of their holes. Depending upon the point of attack, oxy-acetylene torches and pneumatic chippers make relatively quick work of the thinner metal fabric.

The oxy-acetylene torch has proved an invaluable aid to the shipbreaker, but its employment in some places has been found a serious menace to the physical well-being of the

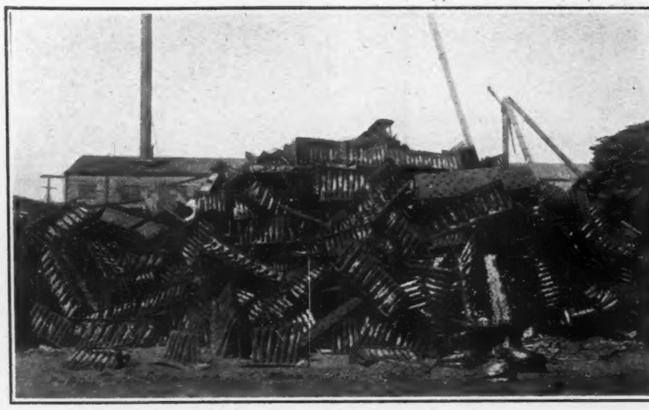


Two of the rectifying columns of the oxygen plant. Within these columns the highly compressed air is brought to the low temperature which causes liquefaction.



One end of the oxygen plant at the Hitner yard. Here air is liquefied and pure oxygen distilled from it to provide one of the gases for the cutting torches.

Parts of a dismembered submarine, which once constituted a unit of our under-water coast defense, outclassed by newer boats.



A pile of cut-up boiler tubes through which once pulsed the motive energy of some of our former battle craft.

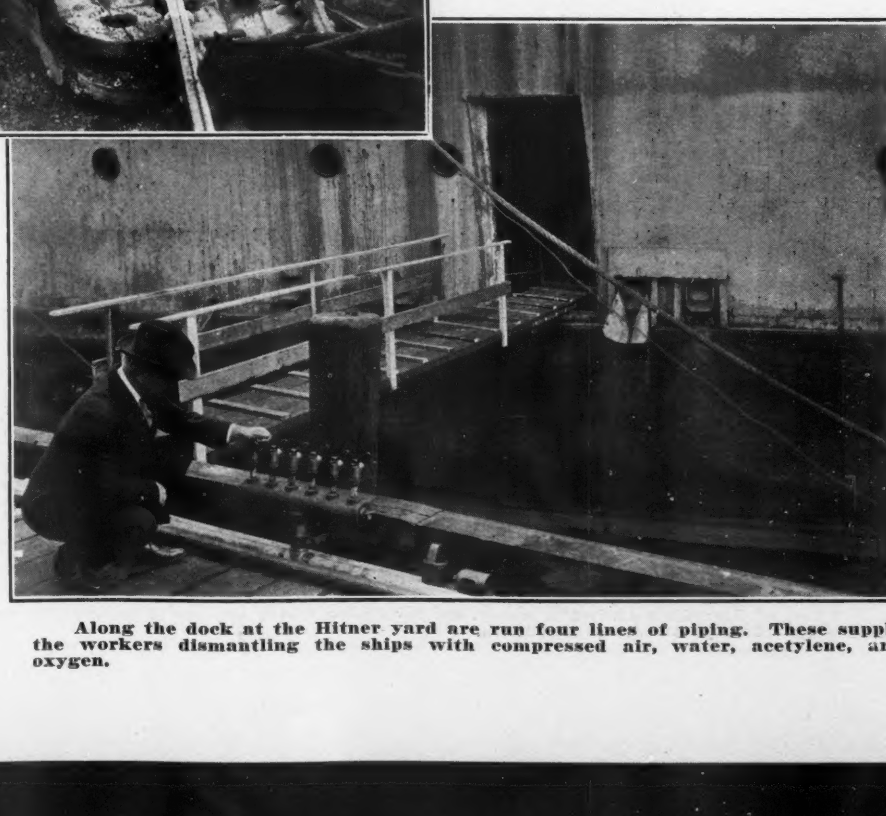
wrecking gangs. This has been notably the case during certain stages of the work inside some of the vessels and especially in compartments no longer ventilated artificially as was the case when the craft were in commission. Cleanliness and smart appearance are prerequisites aboard most of the units of the fighting fleet, and where washing will not assure this paint will. Therefore, during the active life of a fighting ship her metalwork receives many coats of paint, and the thickness of this built-up veneer has been found to be fully a quarter of an inch through in certain of the vessels turned over to the Hitner yard for scrapping. Herein lurks a peril, because the pigment is composed mainly of lead.

Cutting into melting sizes the great steel derrick of a condemned battleship. This work can be done faster and cheaper by oxy-acetylene torches than by any other means.

Not only does paint clog the burner of an oxy-acetylene torch, but the flame of the torch causes the paint to give off a dense smoke which induces what is known among the workers as "lead belly"—a symptom of lead poisoning. To avoid this generation of harmful fumes the men were successively provided with gas masks and respirators, but neither of these protective devices was satisfactory. In confined spaces the smoke became so thick that the operators could not see, and wherever this smoke spread it slowed up activities and was extremely objectionable. To overcome this difficulty, the management at the yard had recourse to pneumatic chippers to cut away the paint from the metal before bringing the torch into action. This greatly reduced the volume of smoke and made it practicable to quickly clear out a compartment by sweeping the atmosphere with a jet of compressed air.

At convenient points, air compressors have been mounted near the waterfront and connected with the system of piping that extends to the pier alongside which the large ships are brought one by one to undergo demolition. Similarly, three other lines of piping carry water, acetylene, and oxygen. It is probably not an exaggeration to say that most of the metal cutting is done by means of the fusing oxy-acetylene torch, which has a flame temperature of 3,600° F. With this torch it is possible to sever a 14-inch armor plate at a speed of six feet in twenty minutes. To facilitate the cutting of armor plate into uniform blocks or slabs of a size suitable for feeding into open-hearth furnaces for remelting, the radiograph has been found decidedly useful. This tool or instrument—call it which you will —is equipped with an oxy-acetylene torch so mounted that its line of travel can be controlled by a long feed screw. One of our illustrations shows a radiograph at work. The guidance of the radiograph is far less fatiguing than the manipulation of the ordinary burner.

Whether the scrap be chunks of armor plate or sections of structural steelwork, none of these must be more than two feet long and



Along the dock at the Hitner yard are run four lines of piping. These supply the workers dismantling the ships with compressed air, water, acetylene, and oxygen.

eighteen inches square if they are to be utilized as remelting stock. Accordingly, it is self-evident that many oxy-acetylene torches must be kept busy in reducing a battleship to marketable scrap. It should be equally plain that the yard must have at hand ample supplies of oxygen and acetylene. To this end, the management of the yard installed an acetylene generator on the waterfront near the shipbreaking pier, and a little further back from the river another concern erected an oxygen plant capable of producing daily a matter of 25,000 cubic feet of gaseous oxygen.

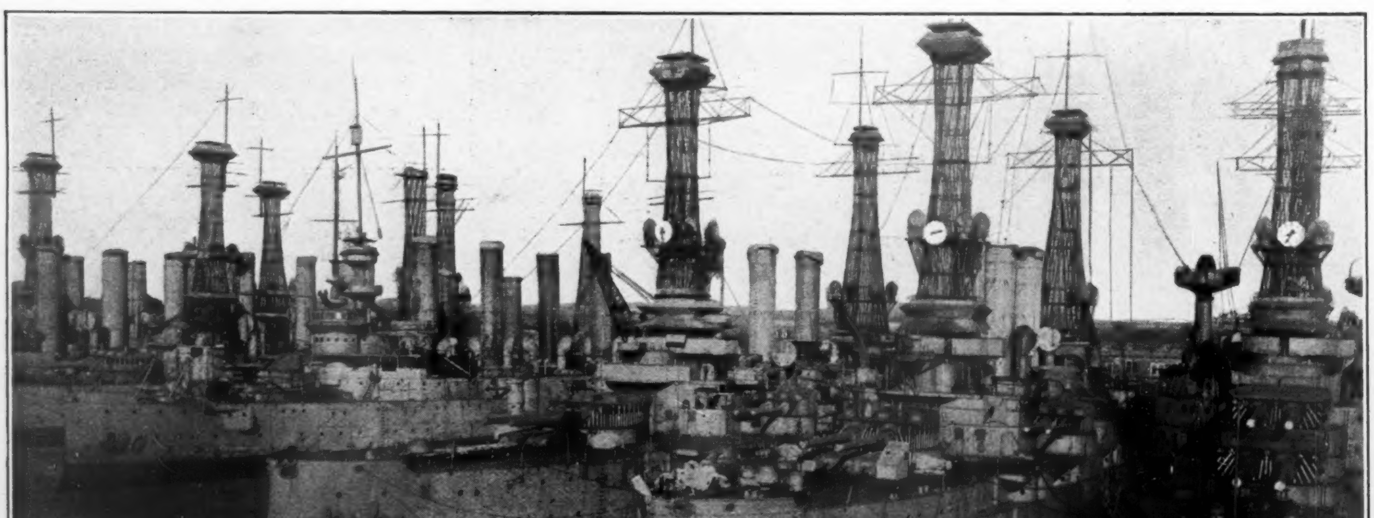
The gaseous oxygen is obtained from the atmosphere by first compressing the free air to 3,000 pounds per square inch and then by chilling this air by allowing it to expand in leaving specially designed nozzles—the cold so induced causing the air to liquefy when a temperature is reached of 294 degrees below zero Fahrenheit. Inasmuch as the oxygen and the nitrogen of the atmosphere when so liquefied have different "boiling points," the oxygen can be separated from the nitrogen by fractional distillation; and the gaseous oxygen so derived is led to a large tank from which it is charged into portable flasks or distributed through piping to points within easy reach of the burners.

It will be understood, of course, that there are many auxiliaries, such as pumps, compressors, electric motors, dynamos, etc., aboard a naval ship sold for scrapping that are still fit for service and for which a market exists. The shipbreaker takes this into account in making his bid for a vessel. When this machinery is of a kind that cannot be disposed of as it stands, then the wrecker must break it up and separate the different metals entering into its get-up. This work may be done with pneumatic tools and with the oxy-acetylene torch, or, perhaps, by simply smashing the parts under a drop hammer or some kindred contrivance.

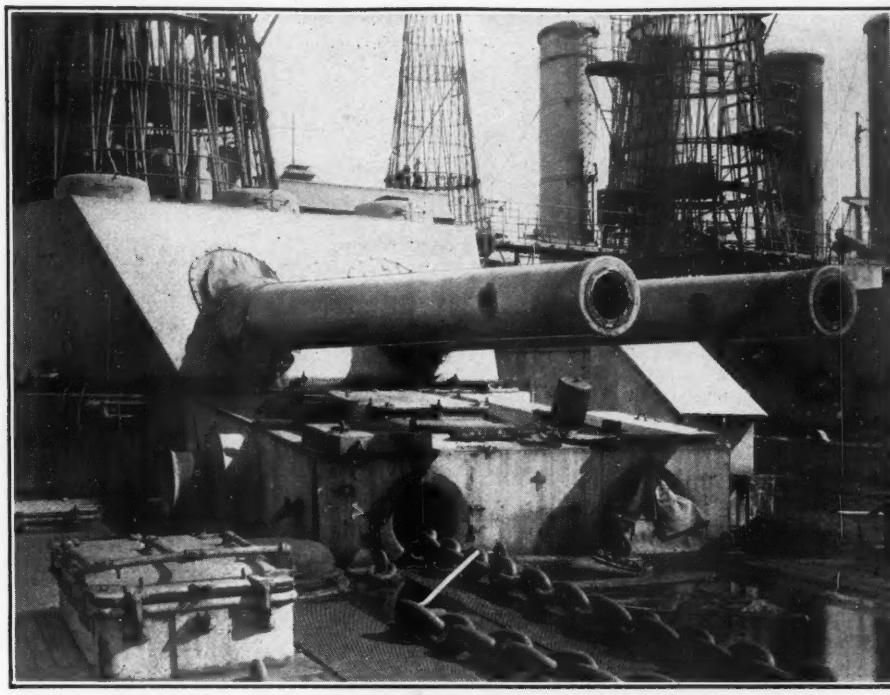
Looking into the bowels of the old "Missouri" after the wreckers had partly reduced that former battleship to scrap metal.

From start to finish, the demolition of a big battle craft is a job that demands engineering knowledge and the taking of studiously thought-out precautions lest collapse occur and ponderous masses of steel come tumbling down upon the workers. The yard is equipped with a great traveling crane which can reach any part of a vessel lying on either side of the pier. It is no uncommon sight to see the scoop-like split halves of boiler shells serving as enormous buckets to raise loads of miscellaneous scrap from the holds of ships undergoing demolition. This is merely an example of the way the expert wreckers make use of the materials at hand.

It is not hard to visualize the steps by which a capital ship is cut down progressively from masthead to just above the water, because as the superposed weight is lightened the hulk rises surfaceward; but even at this advanced stage of breaking up there still is left possibly 1,000 or more tons of metal forming the remnant of the craft's bottom. This portion of the hull is watertight and floats although the rim of this elongated dish projects but a few inches above the surface of the river. The problem is to salvage the metal and not to allow it to fill and sink to the water bed. In the case of small hulls the disposition of this



A few of America's erstwhile sea-going fortresses which are about to undergo conversion into scrap metal to be reworked into numberless peacetime commodities.



These are two of the "Long Toms" of the old battleship "Wisconsin" showing holes burned in their chases to prevent the further military use of the weapons.

final part is not especially difficult, inasmuch as the shell can be run up on the beach at high tide and there cut up section by section as it is hauled out by winches possibly assisted by the lift of the traveling crane.

However, this procedure is not feasible when the remaining bottom is that of a battleship or an armored cruiser, and where, as at Philadelphia, the rise and fall of the tide does not average much over five feet. It is more than likely that the disposition of such a hull section could best be accomplished by grounding it broadside with the beach at high tide and by severing such of the structure as continues submerged at low water by recourse to the subaqueous metal-cutting torch. Of course, the ordinary oxy-acetylene torch can be utilized in cutting any of the steelwork projecting above the water. Compressed Air Magazine described in May of 1922 a submarine torch which had been perfected for tasks of the sort just mentioned.

Recently, the United States naval authorities awarded contracts for the sale not only of a number of old capital ships but for the demolition of some new, partly finished ships which were stricken from the list in accordance with the terms of the International Conference for the Limitation of Naval Armaments. The Government is also asking for bids for the breaking up of certain old battleships used as targets and sunk in navigable waters. This whole subject is interesting both from an industrial and an economic viewpoint; and as time goes on facilities such as we have described will be employed to a much greater extent in dismantling all sorts of iron and steel structures so that their metal can be diverted to other channels of usefulness. The Hitners have long been engaged in undertakings of this nature—among these being the scrapping of the obsolete equipment left by the French engineers at Panama when they made their last attempt to excavate a canal across the Isthmus.

PORTABLES, AND WHAT THEY MEAN TO CONTRACTORS

AT the Detroit meeting of the American Waterworks Association, Mr. F. C. Amsbary, of Champaign, Ill., gave some interesting particulars of his air compressor experiences. "We have in our city," he said, "perhaps 30 miles of concrete pavement and brick laid on concrete; and in case of leaks and extensions it is frequently necessary to go through the concrete. To do this work satisfactorily, we bought an air compressor mounted on a Ford truck. This portable outfit has proved considerably superior to the ordinary compressor that has to be hauled around from job to job.

"We took one job from a contractor who was putting in an ornamental-lighting system. I had him keep a record of just what it was costing him to take out the curb and gutter where he was going to lay his conduits; and in this one case he had a stretch of 121 feet. It cost him 22 cents a linear foot to remove the curb and gutter. On the opposite side of the same street we broke out exactly the same amount of concrete for 9½ cents a linear foot.

"In another instance we removed a stretch of very hard concrete, 21 feet long and 2 feet wide, in 20 minutes, while the best previous record we had on that sort of work showed that it would have taken two men two hours each to do the job in the old way. I might say that there are other uses to which we intend to put this machine. For instance, we have bought a pneumatic spade which, I think, will prove very helpful. It serves to spade up the earth where it is very hard, to turn it over, and then to shovel it out. It simply takes the place of a pick, and does the work much more rapidly."

Pneumatic chippers have been found to be the handiest tools with which to cut out the multiple tubes of a modern high-powered marine boiler.

The Bureau of Standards calls attention to the desirability of keeping wearing surfaces of machinery, etc., as clean as possible. In work for determining the wear of materials it was found that a considerable difference in the rate of wear resulted when the abraded particles were removed from the test specimen than when they were allowed to accumulate. A device for cleaning the specimens during a run has been tried out and proved quite successful. Thereby, the previous results, that is the difference in the rate of wear when the particles are removed and when they are not, were corroborated. When the parts are kept clean, the wear is so small in some cases that it is necessary to make runs lasting several hours in order to get comparative and quantitative data.

Lowering Cost of Pumping Water in a Small Community

Plenty of Good Water At a Moderate Price Is a Problem Confronting the People in Many Sections of the Country

By L. V. ARMSTRONG

PUMPING water in a small community by ordinary methods is usually attended with poor results from a financial standpoint. There are several good reasons for this. In the first place, the efficiencies of small prime movers, with but one exception, cannot compare with those of larger machines of the same type. Secondly, the labor charge does not materially change throughout a considerable range of power: a plant of 100 H.P. will require nearly as much attendance as a 500-H.P. plant. Finally, such items as meter reading, collecting, bookkeeping, and administration will not vary to any great extent in either case.

Therefore, a system of water pumping which is fairly successful for capacities of from 5,000,000 to 6,000,000 gallons a day fails utterly when the daily demand is 2,000,000 gallons or less. To break even, an exorbitant rate must be charged; and, consequently, the consumers criticize the policies of the responsible officials in no uncertain terms; or, following the path of least resistance, the plant is permitted to operate at a loss, and the deficit is made up at the end of the year out of the pockets of the taxpayers. This latter course is manifestly unfair.

It might be of interest in this connection to tell of the experience of Westbury, Long Island, situated about twenty miles from New York City. In general, Westbury's story is not essentially different from that of hundreds of other towns of like size bent upon finding a solution of their water-pumping problem. Accordingly, what Westbury has done may show the people of other places a way out of the woods. Let us emphasize at this point, however, that just as there is no panacea for all diseases so there is no single type of installation that will meet all pumping needs.

The people of Westbury, numbering from 4,000 to 5,000, are of a typically residential type filled with civic pride and progressiveness.

Pumping plant and water tower at Westbury.

This is reflected on all sides by the character of the streets, the appearance of the public buildings, and the attractiveness of the homes. In short, the whole atmosphere of Westbury is such as one would expect to find in the up-to-date suburbs of a great metropolis.

On the outskirts of the town are some very fine country estates owned by men who appreciate the many advantages which Westbury offers. These estates are served by the municipal water plant, as is also the adjacent Township of Carle Place. While the Water Department records show that there are in service but 746 meters to register the water consumed, this figure is not a fair index of the amount of water distributed. Let us make this clear. All the water supplied Carle Place is measured, as far as the Westbury Water Department is concerned, by a single meter, and a similar condition prevails in connection with a number of the large country estates on which there are numerous dwellings drawing water from the central system. As a matter of fact, the average daily pumping output the year round is at the rate of 400,000 gallons. In other words, there is distributed 300,000 gallons every 24 hours during the winter season and quite 500,000 gallons daily in the summertime.

The pumping plant is located about a mile from the railroad station and two short blocks from the main thoroughfare of the town. It is housed in an attractive-looking, low, concrete structure set in spacious grounds provided by the liberal authorities. In consequence, what is so often an eyesore in many places has been made in Westbury a pleasing feature of the community. The commission has endeared itself to the children of the neighborhood by reason of a concrete wading pool, which was built for them alongside the pumping station; and throughout the summer months the youngsters gather there from all directions to splash in the water and to refresh themselves.

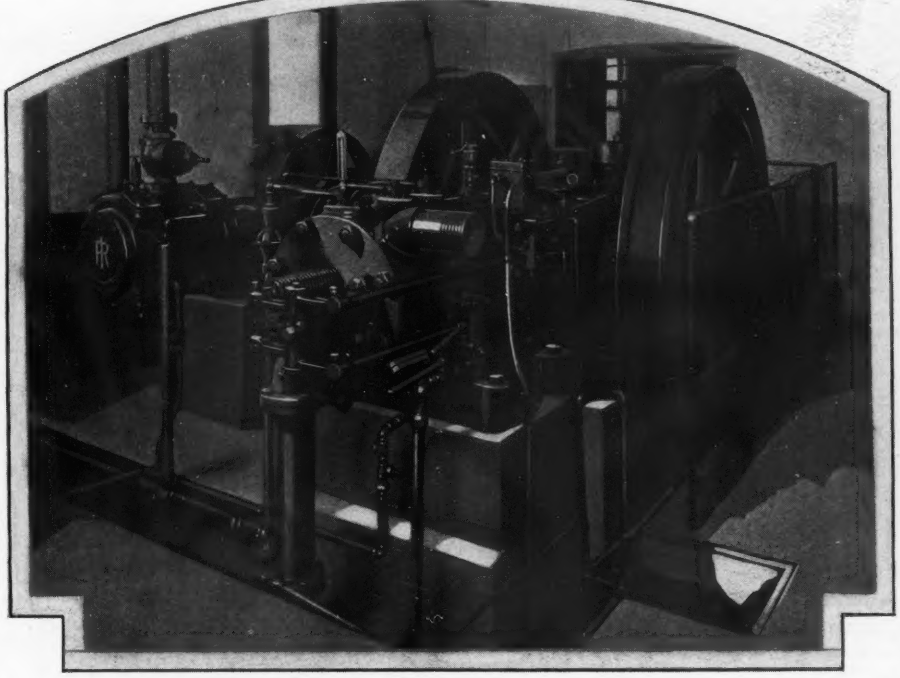
At one end of the power house stand two vertical engines direct connected to triplex pumps. They represent one of the earlier attempts of the commissioners to pump water at a profit. Originally, these engines were intended to operate on producer gas made from anthracite coal; but the difficulty of starting them, aside from the nerve-wracking propensities of the producer, finally resulted in the engines being converted by the manufacturer to run on gasoline.

The rising price of gasoline and the multiplying pump troubles forced the authorities

Westbury's busy highways and its residential streets are evidence of the enterprise and the homelikeness of the town.

to look around for some other method of pumping. Kerosene engines, used in conjunction with an air lift, were chosen. It is interesting to note here that each change represented an improvement and accomplished some reduction in operating costs; but, even so, these successive reductions were not sufficient to effect the desired object: namely, putting the pumping plant on a self-paying basis.

In December of 1922, the commissioners of the Town of Westbury faced a very serious situation in their water department. Not only was this department in a hole financially, but an expenditure of several thousand dollars could not be avoided if the engines were to be put in a condition that would enable them to stand up under the peak-load requirements of the approaching summer. The most discouraging feature lay in the fact that this contemplated expenditure would, as they then saw it, only alleviate conditions—not rectify them. It would not solve the financial problem: it would make it possible to continue pumping water only at a loss.



Ingersoll-Rand oil engine, of 100 H.P., which is direct connected to a 12x10-inch air compressor. The latter furnishes air for the operation of the air lifts installed in the four wells.

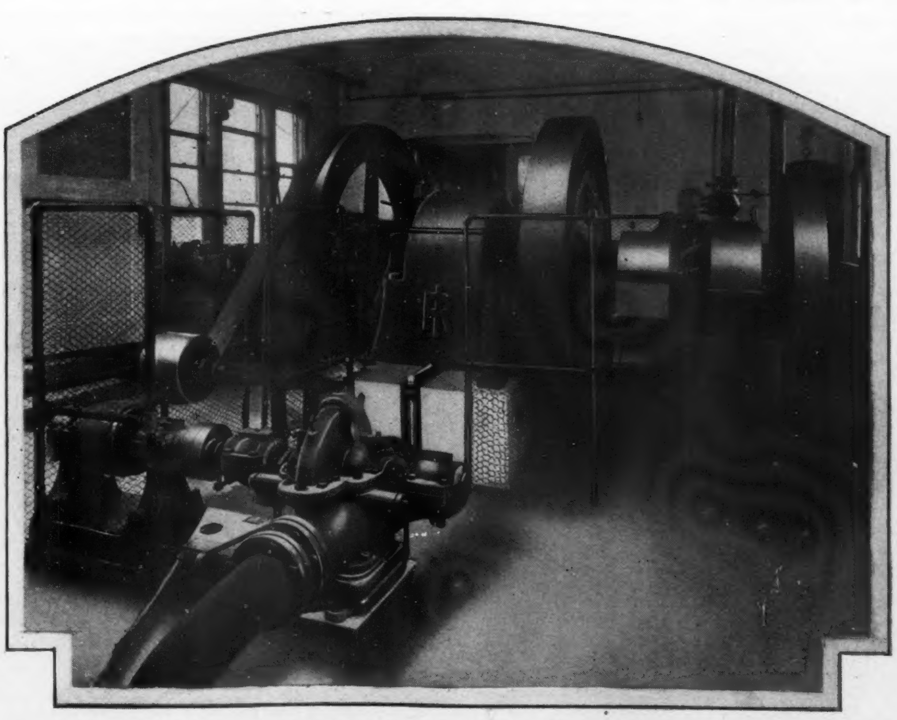
In justice to all concerned, it must be emphasized that neither by act of commission nor omission did any of the responsibility for this state of affairs lie at the door of the present officials. Even preceding commissioners should not be criticized overmuch. There are at this moment, thousands of small communities that are still trying to solve the problem of how to operate a water-pumping plant at a reasonable cost; and much credit is due the authorities of Westbury for having the foresight and the courage to take the one step which could overcome their difficulties. This step involved installing an oil-engine pumping unit.

Much has been said about the economy of the Diesel engine. It is admittedly the most efficient prime mover known to the engineering world. From fuel to horse-power, it is three times as economical as the most highly developed steam plant and 50 per cent. more efficient than a gas engine installation. This inherent economy is affected in but a moderate degree by the size of the unit. To be explicit, a properly designed 50-H.P. Diesel engine will require not quite 5 per cent. more fuel to produce a horse-power than a 1,000-H.P. engine.

But economy is not the sole feature of a Diesel engine that makes it attractive to the large or the small power user. Like any other internal-combustion engine, there are no "stand-by" losses. When there is no demand for power, the engine may be stopped and the fuel consumption ceases *instanter*. Sudden demands for power, as in the case of a fire, are readily met by a Diesel engine. For instance, it can attain full power from a state of rest in two minutes or less; and to do this no special skill is required on the part of the operator.

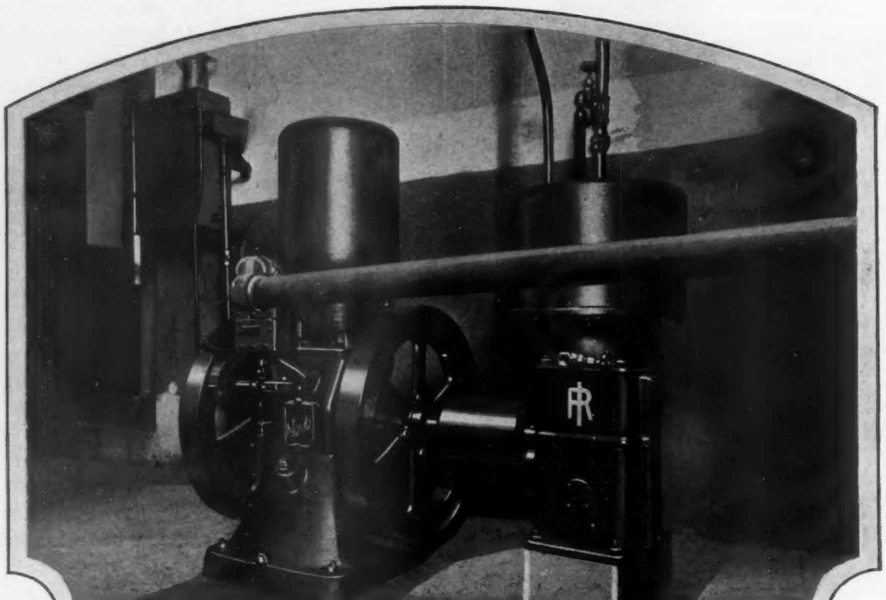
The advantages of a Diesel-engine plant were not unknown to the commissioners of Westbury. However, they had been deterred from seriously considering such a plant because of a report which, if true, would virtually have offset the advantages of fuel economy. In short, it was said that the Diesel engine is a very complicated piece of machinery, requiring specially trained and highly skilled attendants. Conditions were such that the Water Department did not feel justified in spending the taxpayers' money for the purpose of finding out whether or not this criticism was warranted.

About this time the solid-injection oil engine was brought to their attention. With this system, the fuel is injected by means of a very simple plunger pump which does away with the 3- or 4-stage 1,000-pound air compressor—the outstanding feature of the usual air-injection Diesel engine. With solid injection none of the valuable features of the Diesel engine are sacrificed. High fuel economy, quick starting, etc., are all retained, but these are realized in an engine which is as simple as a gas engine. In other words, in the solid-injection oil engine, the one objection to the Diesel engine is overcome—at the same time retaining the characteristic advantages of fuel economy, etc.



The water delivered by the air lifts to the catch basin is raised from there to the tank on the water tower by a small Cameron centrifugal pump which is belt driven from one of the flywheels of the oil engine.

After a careful investigation of the market, the commissioners decided to purchase an oil-engine water-pumping unit manufactured by the Ingersoll-Rand Company. This unit consists of a single-cylinder, horizontal, 4-cycle, solid-injection oil engine direct connected to a double-acting, single-stage Ingersoll-Rand air compressor—a short belt from one of the engine flywheels driving a Cameron single-stage, centrifugal pump. As all the equipment is the product of one manufacturer,



A small compressor, direct connected to a small gasoline engine, supplies starting air for the 100-H.P. oil engine at the pumping plant.

unity of responsibility was assured, and this naturally influenced the officials in their choice.

The compressor furnishes the needful air for lifting the water from the wells into a catch basin. The centrifugal pump then takes the water from this basin and delivers it to a water tower which serves the town. The capacity of the unit is 500 gallons a minute under the existing pressure conditions. The compressor and the pump are balanced as far as capacity is concerned so that one will not get ahead of the other in pumping. As but one unit was purchased, it was decided to retain the kerosene engines as a reserve in case of breakdown.

The new pumping unit has now completed almost a year of service. It has worked throughout the summer months—the season when there is the greatest demand for water and which, therefore, represents the real test for reliability and efficiency. There has been no change in the operating personnel; and though the engineers had had no previous experience with this type or any other type of Diesel engine they have encountered no difficulties.

The cost of pumping water has been astonishingly low. The items entering into the hourly operating cost are as folows:

5 gallons of fuel oil at 8 cents per gallon	$0.40
Lubricating oil	0.05
Labor	1.00
	$1.45

As 30,000 gallons of water are pumped per hour, the cost of pumping 1,000 gallons therefore amounts to four and eight-tenths cents.

Prior to their decision to provide an oil-engine unit, the commissioners had considered the installation of a motor-driven compressor and a motor-driven pump, to be operated by purchased electric power. Had this type of plant been selected, the hourly operating cost would have been as follows:

72 kilowatts at 3 cents per kilowatt	$2.16
Labor	0.60
Lubricating oil	0.02
	$2.78

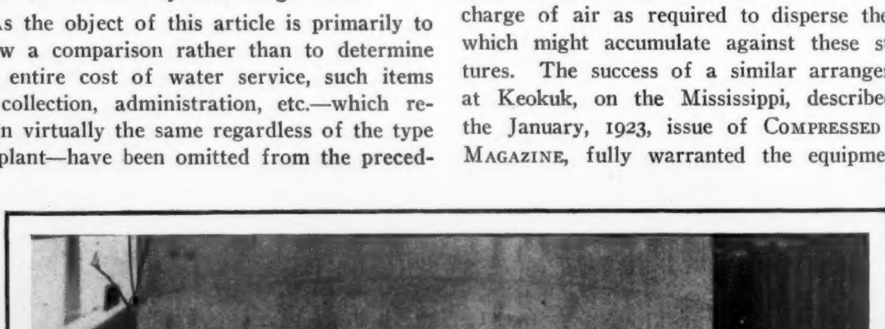
This would have made the cost of pumping 1,000 gallons of water nine and three-tenths cents—approximately double that at which the work can be done by an oil-engine unit.

As the object of this article is primarily to draw a comparison rather than to determine the entire cost of water service, such items as collection, administration, etc.—which remain virtually the same regardless of the type of plant—have been omitted from the preceding tabulations. What the taxpayer wants most to know is how far any improvement in the pumping equipment may affect his pocketbook.

The water-tax rate per $100 of assessed valuation of property was 57 cents in 1922, and last year, because of the savings effected by the new pumping plant, it was practicable to reduce the water-tax rate in Westbury to 28 cents—a reduction of nearly 51 per cent.! The water rate is now 40 cents per 1,000 gallons; but the efficiencies realized in pumping water in the course of the past twelvemonth have been such as to lead the officials to contemplate a cut in this rate. The foregoing figures speak for themselves; and due credit should be given to the town authorities that had the initiative to change or to improve the local pumping plant. The commissioners of the Westbury Water District are: C. C. Boyd, chairman; C. J. Schneider, secretary; and W. Y. Hallock, treasurer.

COMPRESSED AIR PROTECTS DAM AGAINST ICE

A DAM across Cedar River at Waterloo, Iowa, has recently been completed for the Citizens' Gas & Electric Company of that city at a cost of $300,000. It takes the place of a 50-year-old dam destroyed by high water in 1922. A special feature—and until recently a novel and unusual one—is the installation of an air compressor on the operating pier, together with pipes leading to the several gates, for the discharge of air as required to disperse the ice which might accumulate against these structures. The success of a similar arrangement at Keokuk, on the Mississippi, described in the January, 1923, issue of COMPRESSED AIR MAGAZINE, fully warranted the equipment.



International Newsreel Photo.

The base of a reinforced concrete chimney 156 feet high and weighing 450 tons. This smokestack was once the dominant feature of a bustling brewery but was doomed by prohibition. The chimney was tumbled to earth by undermining its 14-foot base; and this was accomplished with dynamite placed in holes drilled by a pneumatic "Jackhamer."

Playful Porpoise a Factor in Helping Us to Be Punctual

The Accuracy of Our Timepieces is Largely Dependent Upon the Character of the Oil Obtained from the Porpoise

By SIDNEY MORNINGTON

FROM the spongy fat in the jowls or jaw pans of the porpoise is extracted an oil which is peculiarly fitted for the lubrication of time-marking mechanisms.

Nut oil, bone oil, seed oil, and mineral oil have been tried in turn for this exacting service, but none of them has proved entirely satisfactory. Therefore, porpoise-jaw oil still stands apart because of its admirable and somewhat unique qualities.

The capturing of the porpoise and the refining of its oil constitute a modest but nevertheless a vitally important industry; and the accompanying article tells something about these little-known activities.

YOU OWN a watch, of course, but how often do you think of the lubricant that plays so important a part in helping that delicate mechanism to mark time correctly? It is highly probable that you have never heard of the source from which comes the best of the oil used for this purpose, and yet the subject is one that should interest you.

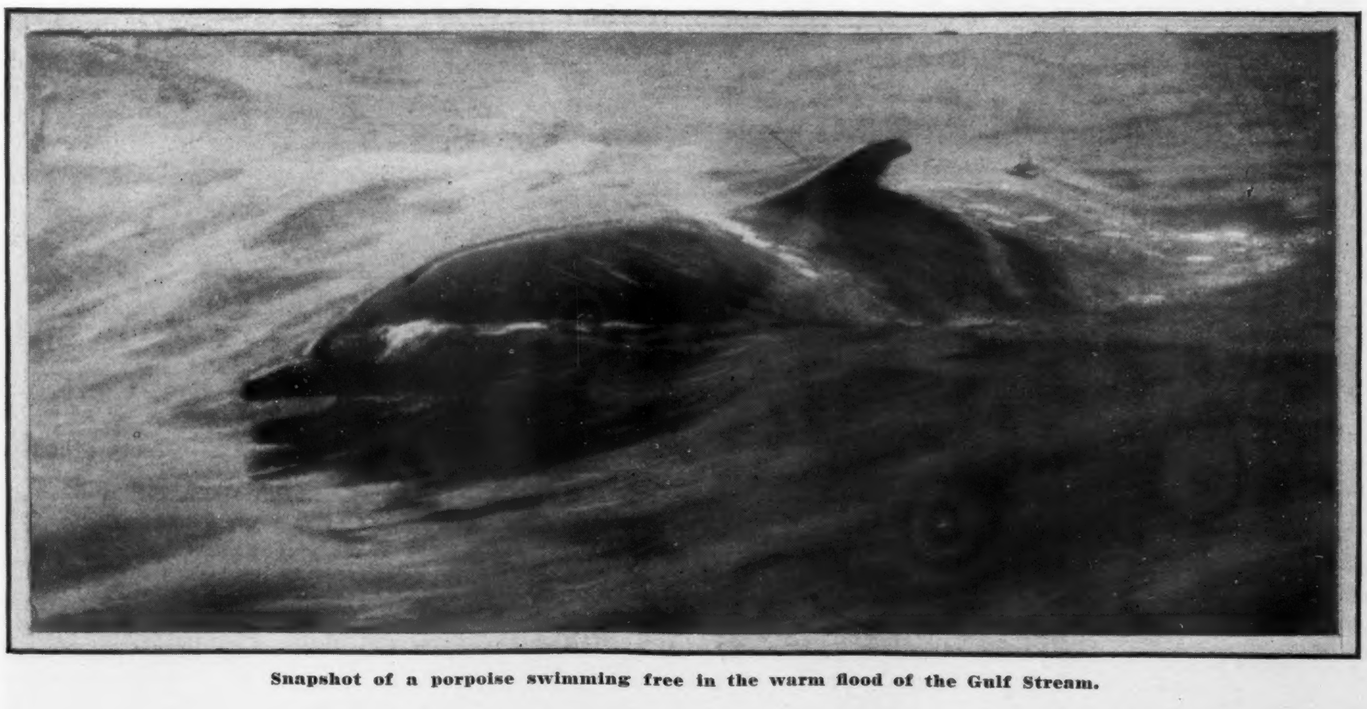
Ever since the clock, as we understand it today, came into being, the problem of proper lubrication has been an ever-present one with the watchmaker. Each improvement in the delicate moving parts has added to the difficulties by making still more necessary the employment of a lubricant which would reduce the friction of those parts to the lowest practicable minimum.

If too thin, the oil would be apt to "creep" or work away from the pinion and the bearing where its presence was essential: if too thick it would just as certainly clog or act as a brake at these very sensitive points of contact. In short, the ideal oil is one that remains fluid throughout a wide range of temperature and yet is sufficiently stable to stay where put and to do the work expected of it. Strange as it may seem, only one kind of oil has so far been discovered which, when properly refined, will measure up to these exacting requirements; and that is the oil which is extracted from the jaw pans of the porpoise—a playful creature, utterly unmindful of the passage of time.

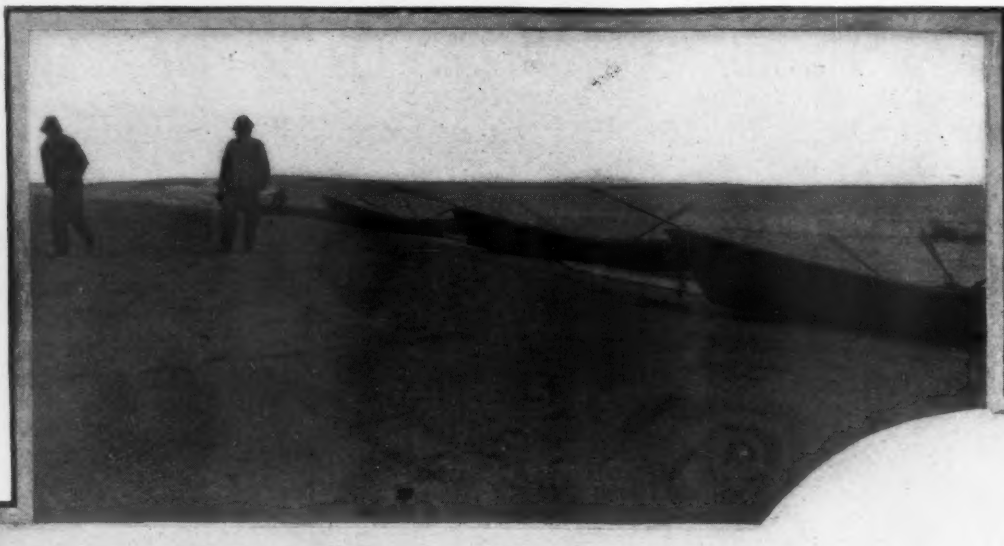
During the day we carry our watches close to our bodies and subject them to blood heat, while during our sleeping hours these timepieces may lie exposed to the chill night air that has dropped well below the freezing point. If we are commuters, we may make or miss our morning trains because of the kind of oil the watchmaker has employed. The lubricant must be equally insensitive to heat or cold and not be apt to thin out when warmed up or to thicken and congeal when exposed to cold. At first blush, these requirements are contradictory, but even so porpoise-jaw oil can satisfy them. Now let us see how the porpoise is captured and how the oil from its jaw pans is refined so that it will be suitable for the oiling of clocks and watches and other delicate mechanisms.

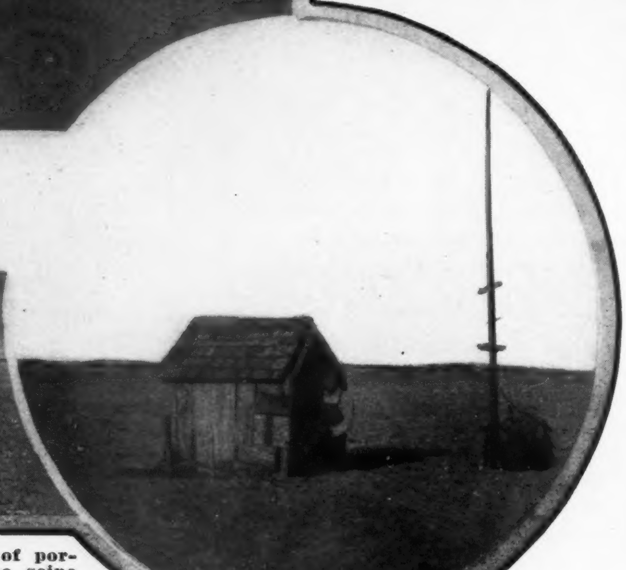
For many years porpoise fishing was a side issue or a mere incident in the garnering of other forms of sea life. "Down East," along the coast of Maine, native Indians have been accustomed for decades to pursue porpoises deliberately—killing them by harpooning, and not infrequently mackerel fishermen have caught occasional porpoises in the course of their day's work. But none of these sources of supply has been equal to the increasing demand for the desired oil. This situation became serious with the appearance of the cheap watch and the rapid multiplication of factories engaged in turning out alarm clocks of various degrees of excellence. Then it was that William F. Nye of New Bedford, Mass., took matters in hand and established a unique industry which would make certain of the capturing of an ample number of porpoises annually to meet the market needs. To supply the demand, something like 3,000 of these miniature relatives of the whale must be caught every twelvemonth.

Mr. Nye, at considerable expense, established a series of fishery stations on the coast of North Carolina in the neighborhood of dreaded Cape Hatteras where the waters of the Gulf Stream hug those sandy shores. These stations are busiest from the first of November well



Snapshot of a porpoise swimming free in the warm flood of the Gulf Stream.





Top—Dories at water's edge ready for launching when a school of porpoises is sighted. Bottom, left—Standing by at the shore end of the seine while the boats surround a school in the offing. Circle—A "spy camp" where someone is always on watch for porpoises seaward.

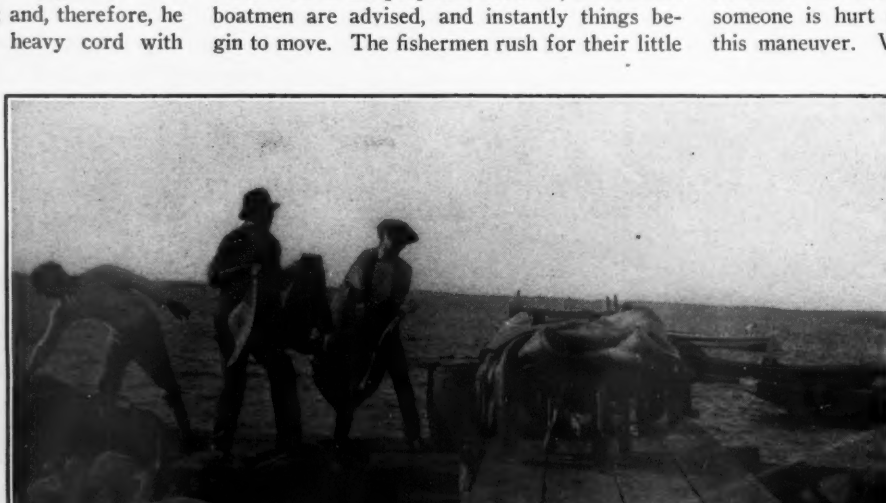
into each succeeding April, during which period the porpoises are cloaked in their thickest coats of fat. The frolicsome mammals vary in length from 6 to 12 feet and range from 300 pounds to double that in weight. Having decided to utilize seines for their capture, it was necessary for Mr. Nye to have nets made of exceptional ruggedness. He knew that the nets would have to be strong enough to halt and to hold the creatures when frightened and seeking frantically to escape; and, therefore, he had his nets fashioned of heavy cord with meshes having a spread of eight inches.

At each station there are a dozen or so men thoroughly skilled in launching their flat-bottomed boats through the surf and in returning them to the beach when making a haul. The risks run in doing this can be more fully realized when we are reminded that the beach dips gradually and that the surf is half a mile or more in width when the seas come pounding shoreward. The porpoises follow the coast line 200 or 300 yards seaward as they pursue the smaller fry upon which they feed. At convenient points, "spy camps" are located and at each of them a watcher is continuously on duty throughout the hours of daylight during the fishing season. The watcher climbs a pole fitted with cross pieces, and from his vantage point aloft he is able to observe the approach of a school of porpoises traveling beyond the line of breakers.

As soon as the porpoises are seen, the nearest boatmen are advised, and instantly things begin to move. The fishermen rush for their little craft, launch them, and then row them with amazing dexterity through the area of rather angry and troubled water. Into each boat has been put a quarter-mile section of seine, and the task is to assemble from two to four of these after the surf has been passed and then to spread the entangling web directly athwart the course of the oncoming, unconscious prey. Care has to be taken to refrain from loud talking or needless noise lest the porpoises be alarmed and turn seaward in a frightened rush.

So far so good; but the crews' work becomes harder and more trying when the school has been surrounded and the porpoises struggle to break through the encircling seines. Then the surfmen must beach the far ends of their nets and draw the porpoises shoreward into shallow water. No time must be lost, yet care must be taken that the skiffs are not overturned or someone is hurt or lost in the excitement of this maneuver. When empty, a mile of heavy seine is hard enough to pull slowly through the water, but the task is a far more burdensome one when the nets are weighted with scores of milling, struggling porpoises fighting to get free.

The number taken at any time varies, but as many as 100 have been landed at a single haul. Averaging 7 feet in length and weighing about 500 pounds apiece, one can comprehend the job involved in beaching a considerable number of these creatures. As the



Stripping the blubber and skins from the porpoises.

seine is drawn shoreward through the surf, the porpoises are stranded in the shallow water—thrashing about violently in their agitation. Now comes the riskiest part of the whole operation, because the fishermen must wade into the water and hook the creatures in order to drag them high and dry upon the sand. A stroke from one of those swishing tails is like the blow of a swinging sledge and may either sweep a man off his feet at a dangerous moment or hurt him seriously.

Porpoises and sharks on the dock of a Carolina fishing station where both oil and leather are made from the sea creatures.

The surfmen have become so expert at this work that they are able to run in among the fish and hook them while dodging their lashing tails; but escape from harm calls for unflagging vigilance and alertness. It takes courage and strength to face the turmoil, for the odds are not so much against the fighting mammals as one might imagine. The greased pig of tradition is an easy mark compared with these slippery, agile, powerful "sea-hogs," as the mariner has dubbed them.

At each fishing station there is a crude outfit for trying out the fat from the porpoises. The head is severed from the body, and the head fat is tried out separately from the body fat. The best of the oil obtained from the fat in the jaw pockets, when refined, brings quite \$50 a gallon, while the oil extracted from the body blubber is very much cheaper. After careful treatment, the body oil makes a superior lubricant for typewriters, sewing machines, and the common run of inexpensive clocks, whereas the jaw oil becomes in time the finest known lubricant for watches, chronometers, high-priced clocks, and kindred delicate mechanisms. But much has yet to be done to make either of the porpoise oils fit for the market. Immediately following the first trying out—during which the fiber settles to the bottom of the try-pots and the oil rises above this sediment, both the body oil and the jaw oil have much the same general appearance.

From the fishing stations, the crude oil is sent to the Nye refining plant at New Bedford; and when it arrives there it is first subjected to gentle heating to complete the cooking process begun by the fishermen. Next, the oil is placed in tanks to await grading; and two years may elapse before the trained eye of the skilled refiner can determine to what class each of the oils belongs. There are only a few men capable of doing this grading; and the classifying is determined by exceedingly delicate variations in color, consistency, and odor. Each grade of oil requires distinctive treatment, and the primary purpose is to get rid of any foreign material which may impair the lubricating qualities of the finished article. Nature helps in the protracted process, during which the oil lies undisturbed and undergoes self-settling.

Progressively, all animal or loose organic matter is separated from the oil by precipitation or straining, and the ultimate aim is to remove any gummy or gelatinous material which would be apt to congeal at moderately low temperature. This is particularly the case with the lubricant for watches. To effect this separation, it was the practice at one time to send the jaw oil to a natural chilling plant at St. Albans, Vt., where it was exposed for a considerable period to winter cold. Oil so refined will not thicken to a troublesome degree, so it is said, when the thermometer registers 50 degrees below zero Fahrenheit. On the other hand, this oil will maintain its body or stability at a high temperature.

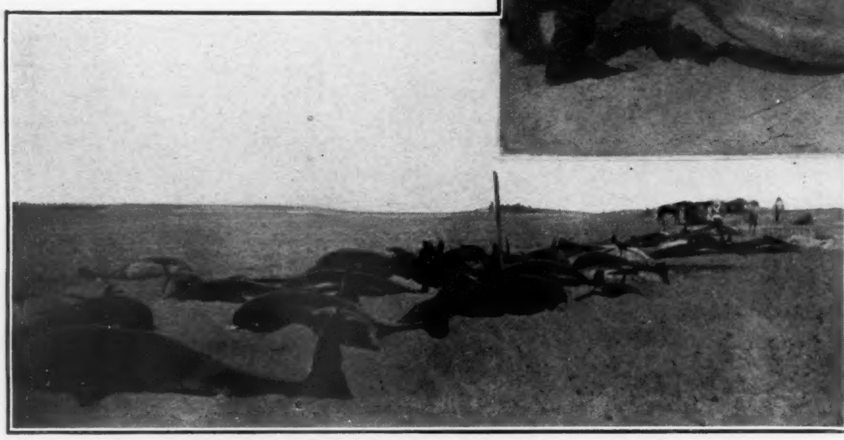
The St. Albans plant answered well enough when the season was a normally cold one, but every now and then a mild winter upset the refiner's plans and delayed the desired precipitation. With the establishment of ice-making and refrigerating plants in New Bedford, Mr. Nye had a solution of his problem at hand, and he was thus enabled to utilize local cold-storage space at any time, the year through, to carry on that phase of the refining of his superior lubricants. In pursuing this course, he has followed the methods employed in certain other industries where the manufacturer has found it desirable to treat his liquid commodities so that they would not cloud or change color when

Left—Only heavy nets are strong enough to land the struggling mammals. Right—Making ready to "cut in" preparatory to trying out the fat. Bottom—A few of a successful haul of porpoises.

chilled. In time, undoubtedly, more and more porpoise-jaw oil will be needed, and when that day comes, and the demand warrants it, the house of Nye will install its own refrigerating equipment. In the meanwhile, available cold-storage space in existing plants will suffice.

The populace at large depends upon porpoise-jaw oil to help it keep its appointments, to connect with trains, and otherwise to give due heed to the passing hours. Just how great this dependence is was emphasized a few years back when one of America's biggest makers of clocks was put to no end of trouble and expense because of a bad lubricant. The company had oiled and shipped from its plant something like 250,000 timepieces, and when the retailer and the ultimate purchaser got hold of those clocks the latter refused to run or did so in a way to make it plain that something was radically wrong with them. In the end, the whole lot had to be returned to the factory where each clock was taken apart, cleansed of the gummy oil, and then touched here and there with a drop of the duly refined porpoise-jaw product.

A long pull and a strong pull finally lands the porpoise high and dry on the beach.



At times the haul is so heavy that horses have to be used to land the catch.

NEWSPRINT INDUSTRY AND ITS PULP-WOOD NEEDS

CANADIAN capital has been invested heavily in the development of newsprint plants close to the sources of pulp wood. The rapid expansion of the industry in the Dominion has been aided by the abundance of available water power, which has led to the installation of improved electrically driven machinery capable of turning out 1,000 or more feet of newsprint paper per minute. This improved equipment has rendered somewhat obsolete many of the older and less efficient plants in service, of which a number can be operated profitably only when there is a big demand for newsprint. Before the war, exports of newsprint from Canada averaged about 133,000 tons annually; by 1920 they had increased to 679,000 tons; and in 1921 they totaled 657,000 tons.

The pulp-wood and newsprint industry in North America, which now produces more newsprint than the rest of the world combined, has been developed on an immense scale; but this growth has not always been directed with due heed to the years to come. As a result of the partial exhaustion of raw materials, the business in the United States has for some years undergone but little expansion, while in Canada the huge timber resources have facilitated rapid growth. But the time has now come when we must look ahead and put the industry on a more permanent basis, that is, adopt a policy of forest conservation.

"In the eastern part of the United States, where the principal mills are located, it has been estimated that present supplies of pulp wood will be exhausted within 20 or 30 years," according to recent pronouncements, "although by the extensive practice of reforestation the cut-over areas near the mills could within 30 or 40 years be made to yield more than the present requirements of the United States.

"Already the pulp and paper mills of some states are importing more than half their supplies of raw material. While considerable quantities of pulp wood are imported into the United States from adjacent freehold lands of Canada, the newsprint manufacturing industry in the United States is beginning to feel the economic effect of having to ship raw material over long distances.

"There are supplies of pulp wood in the United States and its possessions adequate to satisfy the requirements of the newsprint industry for years to come. These supplies, however, are in the Western States and in Alaska, while 90 per cent. of the newsprint mills are in the Eastern States, which are also the main consuming centers. It is impracticable to ship pulp wood a long distance, inasmuch as transportation costs rapidly cut down the margin of profit.

"Apparently, the most feasible plan that will make certain of a source of raw material for the newsprint industry established in the Eastern and Lake States is to adopt a policy, similar to that of many European countries, of reforesting cut-over and waste areas. More than 60,000,000 acres of potential forest lands accessible to the existing pulp and paper mills are now producing nothing. An annual production of one-third of a cord of pulp wood per acre would yield 20,000,000 cords, or three times the present consumption in the United States."

Several of the large companies in Canada and the United States are now carrying out extensive programs of reforestation so that they may be assured an adequate supply of raw material when their present stands of virgin timber are cut. A vigorous campaign of reforestation and efficient methods of fighting forest fires will do much for the future success of this vitally important industry in both countries. Fire, we are told, has destroyed more timber and caused more losses than all the industries combined, and has, therefore, added measurably to the acuteness of the situation.

DETECTING WATER VAPOR IN GAS OR AIR

AN instrument for indicating the quantity of water vapor present in a gas—including compressed air—has been invented at the Bureau of Standards, a description of the same being given in Technological Paper No. 242. The device can be used to detect smaller amounts of vapor than can readily be registered by any other means; and it can be employed inside high-pressure piping.

Its action depends upon the fact that the electrical resistance of a thin film of sulphuric acid, or other water-absorbing substance, varies with the moisture content of the air or gas to which it is exposed. A small quantity of vapor is absorbed by the film and increases its conductivity; but if the gas becomes drier some of this water is again released. The desired film is formed in a narrow, etched line between two thin layers of platinum on a glass tube.

PNEUMATIC PORTABLE SCRAPER LOADER

AN INTERESTING and effective form of air-operated scraper loader has been devised by Mr. A. J. Wagner, efficiency engineer of a prominent iron mining company in the Gogebic Range, Michigan.

This portable scraper loader was first produced in the fall of 1922, and because it proved decidedly successful the Wagner loader, or some modification of it, is now extensively employed by operators in this territory for drift mucking and similar work. The Wagner loader consists of a double-drum "Little Tugger" pneumatic hoist mounted on a truck, equipped with rail clamps, which carries an inclined slide of steel, a folded apron, and an extension track on which the scraper rides over the muck car. The slide is constructed of ¼-inch plating, is 42 inches wide, and is fitted with 5-inch angles at the sides that serve as guides for the scraper and likewise prevent spilling. The apron is made of three pieces of ¼-inch plating hinged together as well as to the slide in such a way that the apron can be folded back on the slide when it is necessary to move the loader. The front of the apron is flared out to a width of 84 inches so as to guide the scraper onto the slide from the drift bottom.

The extension track is pinned to the slide and supported at the end by hinged legs which stand upon blocks set on the drift bottom. When in use, it is customary to steady the extension track by means of a couple of sprags wedged against the drift timber. The scraper ropes are led from the hoist drums over idler sheaves, hung on the slide frame, and thence to a pair of pulleys mounted at the end of the extension track. From the pulleys the ropes run to a snatch block suspended at the breast of the drift.

When in action, the operation of this loader follows the usual scraper practice. The loader is set with the apron resting on the drift floor at the end of the track—usually 25 or 30 feet back from the breast, and is moved forward a rail length or two at a time. Generally, this movement is regulated to maintain the travel of the scraper at a maximum of from 65 to 75 feet.

In handling ore, ore formations, slates, and kindred materials, which do not break into exceptionally large chunks, it has been found possible to load ordinary 3-ton mine cars in from two to five minutes—depending on the stuff dealt with and the length of the haul. As the speed of mucking is contingent upon car service, it seems that this type of loader is fully fast enough to meet the usual movement of the cars.

Little time is required to make the loader ready for shifting. The procedure is simple: the scraper is pulled up on the slide, the hinged apron is folded back, and the rail clamps are loosened. With these things done, the extension track is then disconnected from the slide and placed on an empty car—thus the loader is moved in two sections to a new point of operation.

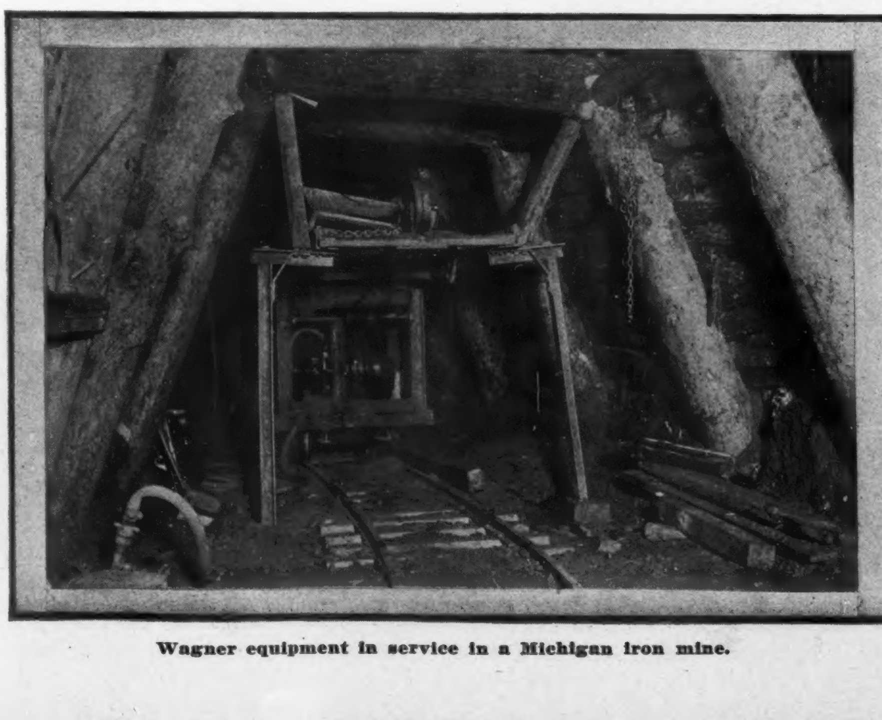
The experience of users of this type of loader has disclosed, among other merits, the following advantages: Unnecessary to move while blasting; the loader does not require the services of a skilled attendant; no short lengths of rails are needed as the drift advances; low up-keep cost—rope renewal being the principal repair item; and low first cost, which amounts to about $1,000 and includes the price of the pneumatic hoist, ropes, and scraper.

Wagner portable scraper loader is another proof of the adaptability of the air-driven "Little Tugger" hoist. The hoist is mounted on the 4-wheel truck beneath the inclined steel slide.

COMPRESSED AIR STOPS A GAS-MAIN FIRE

NOT long ago, while some street-excavation work was in progress in one of our cities, a gas main was broken, and the gas flowed out in large volume. The occurrence was serious enough, if not altogether unfamiliar, but in this case the gas in some way was ignited, and then the situation became desperate. To shut off a gas main supplying numerous customers is a more or less grave matter because it may endanger life and property, especially when it comes to turning on the gas again. Therefore, it was determined to extinguish the flames, but this was more easily said than done. The device adopted, however, was essentially a simple one, and proved completely successful.

Holes were drilled in the gas main, one at each side of the blaze and as near as possible to the fire to permit working without risk. Through each hole, 1½ inches in diameter, was passed into the main a collapsed leather bag with a small air pipe attached. Each pipe, when distended, assumed a globular form somewhat smaller than the internal diameter of the main. Connections were then made with a portable air compressor; pressure was carefully applied; and the two little bags were blown out so as to entirely plug the main. Thus the flow of gas was cut off at once, and the big flame was immediately extinguished. It is to be remembered that the normal pressure carried in a main is extremely small, measured by a few inches of water, so that the stopping of the flow was an easy matter after all.



Wagner equipment in service in a Michigan iron mine.

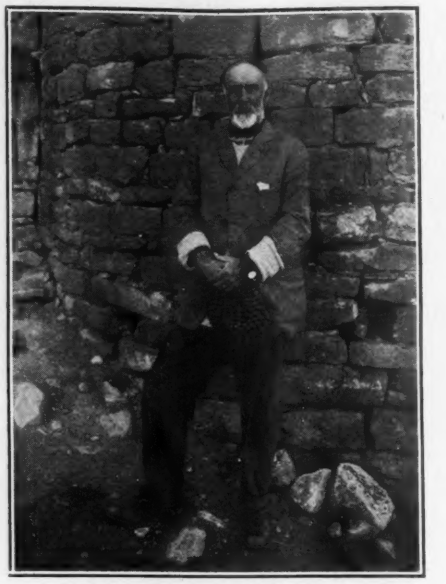
AMERICAN STONE DWELLINGS OF PREHISTORIC DATE

WHETHER or not the archeologist will ever be able to trace man's presence upon this continent to a time thousands of years prior to the coming of Europeans is still an open question, but we can be certain that human races or tribes held forth in America centuries before the white man arrived. These people attained to a cultural and communal development far in advance of anything prevailing among the Indians or red men found here by the first of the colonists.

Who those prehistoric people were has yet to be ascertained, neither can we tell whence they came, but proof positive we have that they occupied regions on this continent remote from the sea showing—no matter what their origin—that they had penetrated far into the primeval wilderness. Very appropriately, some of these areas have been taken over by the Government to insure their preservation, and among the latest of these so-called national monuments is Hovenweep, meaning Deserted Valley, which lies in adjacent sections of Utah and Colorado.

This reservation contains four separate groups of remarkable prehistoric towers, pueblos, and cliff dwellings that were gradually falling into decay and being depredated by relic seekers before the Government assumed control of the property a year ago. The area contains something like 285 acres, and from now on care will be taken to preserve these monuments of a departed people while experts carry on heedful explorations which may reveal definite facts about the human beings that once held sway there.

No one has yet ventured to fix with any positiveness the date when these ruins were in their architectural prime; but a tree growing atop the highest wall of one of the prehistoric buildings in this territory disclosed 360 annual rings when cut down in 1915. How old the wall was when that tree first found lodgment there cannot now be determined; but we do know that a pioneer Spanish priest mentioned in the log of his explorations, as far back as 1775, the existence of ruins upon the route traced by him along the Dolores River in Colorado. The ancient dwellers of the crumbling structures had disappeared long before that time.



Courtesy, National Park Service.

Dr. J. Walter Fewkes, Chief of the Bureau of American Ethnology, who is our foremost authority on the prehistoric culture of the Southwest.

Two of the ruins in the new national monument, namely Hackberry and Keely, are in Colorado, while the Ruin Canyon and Cajon groups are in Utah. Each lies within a mile of the well-traveled road between Dolores, Col., and Bluff City, Utah. The Ruin Canyon route consists of eleven structures, the largest of which is Hovenweep Castle, 66 feet long and 20 feet high. The Keely group is made up of five prehistoric buildings, the standing walls of one of them measuring 20 feet in height. The Hackberry group is composed of five buildings with well-preserved walls, and the Cajon group includes important antiquities. The majority of the structures belong to unique types not found in other national monuments, and are examples of the finest prehistoric masonry in the United States.

In one case, that of Ruin No. 7 or Eroded Bowlder House, the mortar in some of the protected parts of the walls still bears the impress of human hands; and we are told by Dr. J. Walter Fewkes, Chief of the Bureau of American Ethnology, that "at one place there are the indentations of a corncob used by the plasterers to press the mortar between the layers of stone." An accompanying illustration is a photograph of the famous Twin Towers, situated in Square Tower Canyon; and this picture serves admirably to give a true idea of the character of the stonework of the vanished builders.

Speaking of these vestiges of advanced prehistoric culture of man in America, Doctor Fewkes has said: "This culture reached its apogee and declined before the historic epoch, but did not perish before it had left an influence extending over a wide territory, which persisted into modern times. Through the researches of archeologists the nature of this culture is now emerging into full view; but much material yet remains awaiting investigation before it can be adequately understood."

In his report some years ago, this eminent authority pointed out: "The data here published should not be interpreted to mean that the author regards the builders of the towers and great houses here described as evidences of a race other than the Indians. Indeed, he believes that in both blood and culture they have left survivals among the modern Pueblos. He also does not hold that as a whole they necessarily belonged to a radically different phase of culture, notwithstanding the buildings they constructed show a greater variety of form and masonry superior to that of their descendants. The evidences are cumulative that there existed and disappeared in a wide geographical area of the Southwest a people whose buildings differed so much from those of any other area in North America that the area in which they occur may be designated as a characteristic one."

Courtesy, National Park Service.

The famous Twin Towers, situated in Square Tower Canyon, built in America by an ancient people. These ruins now form part of the Hovenweep National Monument.

MAKING A RECORD BLAST

EACH big blast is continually being succeeded by a bigger one. Here is one, however, that should hold the record for some time to come. At Lakeside, on the west shore of Great Salt Lake, Utah, a mountain 275 feet high was recently shattered for a length of 1,000 feet into workable fragments by the explosion of more than 150 tons of Hercules "Special" dynamite. It was estimated that the explosion tore loose more than 550,000 cubic feet of rock—lifting it into the air and distributing it over an area of 360,000 square feet—and reduced it to a form ready for ballasting and strengthening the land approaches to a cut-off on the Southern Pacific Railroad.

Six tunnels were constructed which had an aggregate length of 4,100 feet. These tunnels varied in depth from 110 to 160 feet and had crosscuts at the ends and centers running for from 50 to 90 feet. It took 25 men 40 days to place the powder; and the blast was exploded by a direct-current circuit from a special dynamo car. Engineers from far and near witnessed the explosion, the cost of which, including material and labor, amounted to about $100,000.

Progress on the Big Creek Hydro-Electric Project

Giving Details of the Monumental Work in Connection With Development No. 3

PART IV

By D. H. REDINGER*

IMMEDIATELY upon the completion and the putting into service in August, 1921, of Power House No. 8, described in the preceding issue, construction was started on the fourth station—to be known as Power House No. 3—of the Southern California Edison Company's Big Creek hydro-electric system. The ultimate generating capacity of this plant will be 210,000 H.P., but the initial installation, finished in the early part of October, 1923, consists of three 35,000-H.P. units, or a total of 105,000 H.P. This plant is located on the San Joaquin River, about seven miles downstream from Power House No. 8, and utilizes the waters of the San Joaquin, including Big Creek and all tributaries above the mouth of Big Creek, and of Stevenson Creek, which joins the river at a point between the mouth of Big Creek and Power House No. 3. These waters flow into Tunnel No. 3, and finally pass through the turbines of this new power house.

Dam No. 6, built across the San Joaquin River just below Power House No. 8, diverts the waters of that stream into Tunnel No. 3, which has a length of 5.4 miles from its intake to its outlet portal. The waters are then carried down the steep side of the mountain through three steel penstocks, 1,300 feet long, to Power House No. 3, which is located on the eastern bank of the San Joaquin. The elevation of the spillway crest of Dam No. 6 is 2,230 feet above sea level, while the water level of the tailrace at Power House No. 3 is at Elevation 1,400—thus giving a static head on the turbines of 830 feet. Allowing for friction losses, this results in an effective head of approximately 700 feet.

Diamond-drill core borings were made at three separate places before a suitable site for Dam No. 6 was found; and the site finally selected necessitated excavating into the existing river channel to a maximum depth of 35 feet. This concrete dam, which is of the simple arch type, has an upstream radius of 180 feet; the base has a maximum thickness of 37 feet 9 inches; and the spillway crest is 8 feet wide. The spillway is designed to handle a maximum discharge of 50,000 second-feet of water. The top of the gate-operating platform and footway is at Elevation 2,250, that is, 20 feet above the spillway crest, while the lowest point of the excavation is at Elevation 2,100, making the maximum height of the dam 150 feet. The overall length of the dam and footway is 430 feet. Four 7x7-foot rectangular sluice gates have been provided at Elevation 2,145 as a means of drawing down the pond and of sluicing through the dam any sand deposits which may have accumulated at that point. There are no flashboards, gates, or siphons on top of the dam, as the structure is of the simple over-flow type.

Before operations could be pushed at Power House No. 3 it was necessary to drill and to blast a roadway along the face of the precipitous slope at the right.

To carry the flow of the river during the excavating of the dam site, a timber by-pass flume was constructed having a capacity of 5,000 second-feet. This was done only after a careful study of the hydrographic records of the San Joaquin proved this to be the maximum flow at that particular point during the period of the year when it would be necessary to divert the waters into the flume. The flume—which is 530 feet long, 28 feet wide, and 15 feet deep at the intake end and 6 feet deep at the outlet end—was built upon a bench excavated at water-level elevation along the south bank of the river. The intake end is about 150 feet upstream from the dam site; and at that point a cofferdam of timber and sacks of dirt was placed across the stream. A pocket of sand

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composed of disintegrated granite was discovered on the side of the mountain almost directly above the dam, and a large amount of this material was sluiced into the cofferdam and helped to make it comparatively watertight. A small cofferdam was also constructed at the outlet of the diversion flume, thus enclosing the dam excavation and protecting it against backwater from the river. Altogether 56,000 bags of earth were used in the two cofferdams, and 3,400 cubic yards of material were sluiced from the mountain sides.

Three Marion shovels, two of which were operated by compressed air, were employed on the dam-excavation job; and a tramway, equipped with a pneumatic hoist, was built on the west side of the river to carry the muck to the dump, situated downstream. Ten centrifugal pumps, ranging in size from three to eight inches, and three small horizontal piston pumps were installed to handle the water seepage. Bedrock of hard, gray granite was uncovered throughout the entire site, and this insured a rough foundation—in other words, a perfect bond for the concrete. A few seams were encountered in the foundation, and these were grouted under pressure.

View of the rough way along Stevenson Creek that had to be traveled in opening up the road preparatory to beginning construction work on Project No. 3.

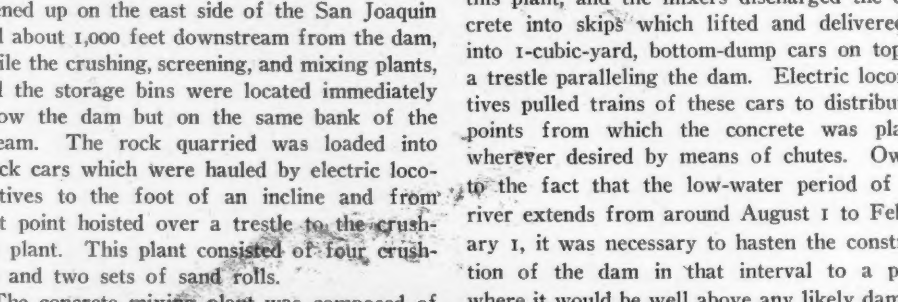
The excavation in the river bed was completed November 15, 1922, when the erection of concrete forms was started. The needful concrete materials were secured from a quarry opened up on the east side of the San Joaquin and about 1,000 feet downstream from the dam, while the crushing, screening, and mixing plants, and the storage bins were located immediately below the dam but on the same bank of the stream. The rock quarried was loaded into muck cars which were hauled by electric locomotives to the foot of an incline and from that point hoisted over a trestle to the crushing plant. This plant consisted of four crushers and two sets of sand rolls.

The concrete mixing plant was composed of one 2-cubic-yard mixer and one 1-cubic-yard mixer put up between the storage bins and the dam. A belt conveyer carried the sand and rock from the bottom of the storage bins to this plant, and the mixers discharged the concrete into skips which lifted and delivered it into 1-cubic-yard, bottom-dump cars on top of a trestle paralleling the dam. Electric locomotives pulled trains of these cars to distributing points from which the concrete was placed wherever desired by means of chutes. Owing to the fact that the low-water period of the river extends from around August 1 to February 1, it was necessary to hasten the construction of the dam in that interval to a point where it would be well above any likely damage by floor water. The entire concrete plant was, therefore, planned with this in mind; and it had a capacity of 400 cubic yards per 8-hour shift.

The placing of concrete was commenced on November 20; and by December 6 the portion of the dam west of the by-pass flume was poured up to Elevation 2,162, that is, 4 feet above the top of the by-pass flume. The rectangular sluice gates in this section were concreted; and in addition to the four 7x7-foot gates three 8x12-foot temporary openings were left to divert the flow of the river while the foundation for the dam under the by-pass flume was being excavated and concrete poured up to a safe elevation above the river channel. Concreting was stopped on December 6, and the flow of the river was then carried through the sluice gates and the temporary openings. The by-pass flume was next removed so that that part of the dam site could be excavated. This work was finished on December 27, when the pouring of concrete was resumed.

The placing of concrete on this job was completed on February 28, 1923, except for the closing of the temporary openings in the dam. These openings were provided with stop-log guides at the upstream and the downstream ends. Stop logs were placed in these guides and the openings filled with concrete during March following, the last opening being closed on the 18th of that month just a few days before the first spring flood in the river. The dam is made up of a total of 19,900 cubic yards of concrete. Wooden forms were used throughout. These were built in place and were supported by the trestle carrying the track and the supplemental staging.

Two high-line cableways, one having a 2¾-inch and the other a 1½-inch standing line, were strung at an elevation of approximately 200 feet above the crest of the dam to assist in the handling of materials—a short spur from Incline No. 8 bringing them up to the east end of these carriers. Cement, lumber, in short practically all equipment and supplies for the



Camp 35 on Stevenson Creek. The steep and rugged nature of the valley did not daunt the engineers in placing their operating bases so that they would be near the sites of certain adits.

Close-up of a drilling gang engaged in clearing the way for a road along the face of a precipitous cliff.

construction of the dam were delivered by these two cableways, except at the start when an auxiliary incline was in service. This latter connected with the lower end of Incline No. 8 and ran thence to the intake of Tunnel No. 3, which is about 300 feet upstream from the dam.

While all this work was in progress, the intake structure for Tunnel No. 3 was likewise being pushed, inasmuch as it was imperative that it, too, be completed before high water. This intake is designed to control the flow from the reservoir into Tunnel No. 3; it is built of concrete and steel; and it rises 100 feet from the lowest point in the foundation to the operating platform, at Elevation 2,250—the same elevation as that at which the gate-operating platform and bridge are located on Dam No. 6. The circular concrete building which houses the operating machinery reaches 33 feet above this operating platform. The front of the tower is made up of galvanized rack bars supported by galvanized structural beams. This rack-bar screen, which extends the full height of the tower, is 44 feet wide and is composed of ⅜x3½-inch bars spaced 1⅛ inches between bars. An accompanying illustration gives a good view of this structure.

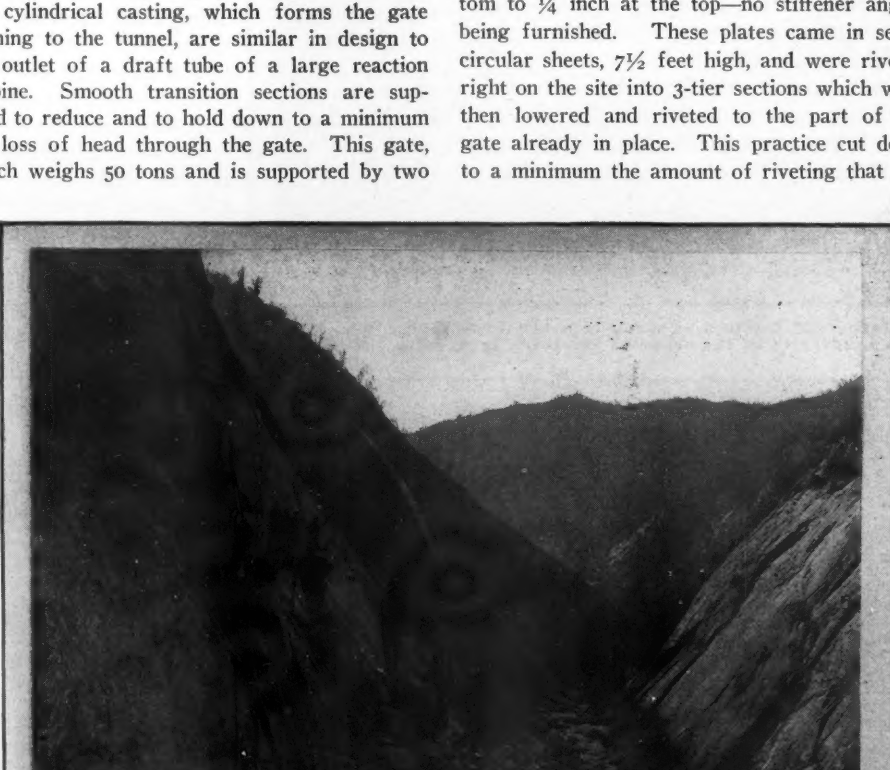
A single cylindrical gate, 22 feet in diameter and 77½ feet high, controls the flow into the tunnel. This cylinder operates in a concrete well having a diameter of 28 feet. Steel rail guides, set in concrete at the lower end of the gate, accurately seat the gate on a heavy, iron casting provided with a soft-metal gate seat. Similar steel rail guides at the top of the tower keep the upper end of the gate in alignment. The water passages leading to and from the cylindrical casting, which forms the gate opening to the tunnel, are similar in design to the outlet of a draft tube of a large reaction turbine. Smooth transition sections are supplied to reduce and to hold down to a minimum the loss of head through the gate. This gate, which weighs 50 tons and is supported by two 4¾-inch gate stems, is functioned by an electric motor and fitted with an auxiliary gasoline engine for emergency drive. Two 36-inch by-pass gates are provided for filling the tunnel and for equalizing the pressure on the inside and the outside of the gate before operating it.

The cylindrical gate is made up of plates varying in thickness from 7/16 inch at the bottom to ¼ inch at the top—no stiffener angles being furnished. These plates came in semicircular sheets, 7½ feet high, and were riveted right on the site into 3-tier sections which were then lowered and riveted to the part of the gate already in place. This practice cut down to a minimum the amount of riveting that had to be done in the restricted space in the tower between the gate and the concrete.

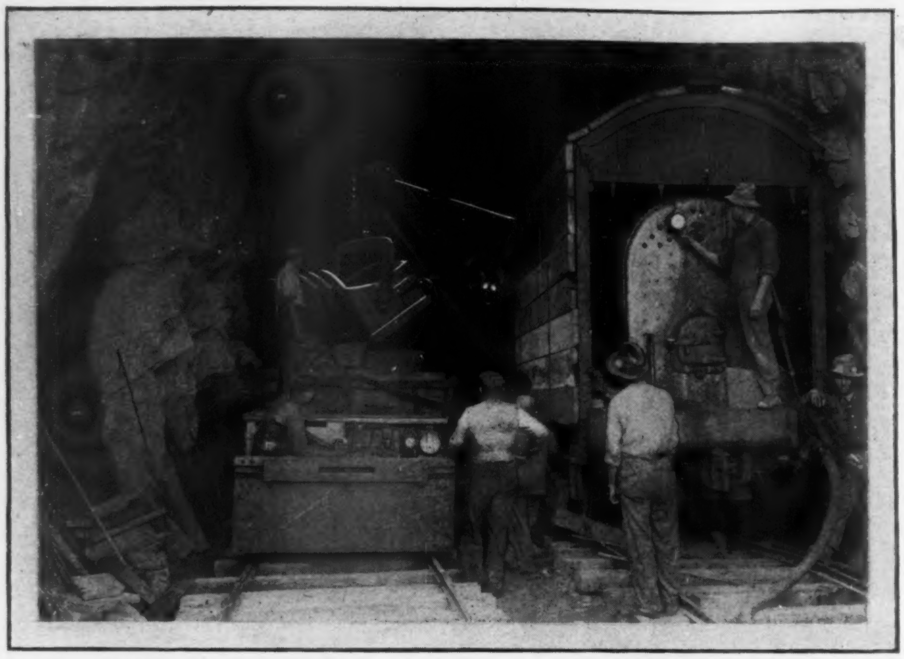
A matter of 3,905 cubic yards of granite was excavated for the foundation and the side walls of this intake structure—the job, which was started on November 25, 1922, being finished in 26 days. Concreting was begun January 6, 1923, and was completed, with the exception of the small house over the operating mechanism, by March 17 following—the entire structure having required 2,900 cubic yards of reinforced concrete.

Before the construction of Project No. 3 could be undertaken, it was essential that some means of transportation be provided along the tunnel line and to the power-house site in order to establish camps and to deliver the necessary materials, supplies, and equipment. Owing to the steep and rugged nature of the country, this was an extremely difficult task. Two schemes presented themselves: that of building cable-operated inclines from the San Joaquin & Eastern Railroad—located up the slope of the canyon some 2,000 feet higher in elevation—to each of the three tunnel adits and to the outlet portal, or that of running a road on tunnel grade down the canyon, between Power House No. 8 and the site of Power House No. 3, which would link all the construction camps. After duly weighing all the pros and cons, the decision was in favor of roadways. These, it was argued, would prove of value not only in the future operation of the hydro-electric stations but would, likewise, be of benefit to the public by opening up to the autoist one of California's scenically beautiful canyons.

The main highway as built is seven miles long between the tunnel intake and the outlet portals, and continues in a southwesterly direction for four additional miles until it joins the San Joaquin & Eastern Railroad at Hairpin. A branch road of 1½ miles leads to Camp 38 at Power House No. 3, making a total of 12½ miles of roadways.



Drilling blast holes with pneumatic rock drills in building a road in a canyon where the bare rocky walls had an average slope of 45 degrees.



Air-operated steam shovel especially equipped with an 11-foot dipper stick so that it could do mucking within the 21x21-foot tunnel section.

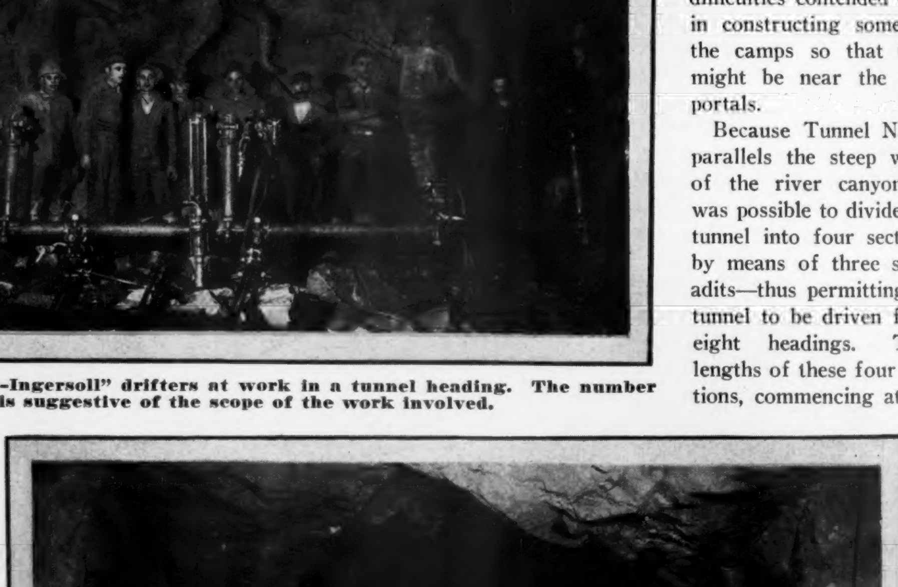
Road construction was started on August 10, 1921. For the first six miles, working downstream from Power House No. 8, the road is what might be called a notch in the smooth granite walls of the canyon. The difficulties that had to be contended with in getting a footing along this stretch and the dangers run can readily be appreciated when it is understood that the sides of the canyon had an average slope of 45 degrees, and that in many places they dropped almost sheer. Cuts of 50 feet on the upper edge of the road are common, and in some places they are as high as 100 feet with as much as 15 cubic yards of rock per linear foot excavated. Accompanying illustrations give a good idea of some of this heavy rock work. At times, the methods employed resembled tunnel driving rather than road construction—a regulation heading having been carried forward. Drilling was done with pneumatic "Jackhamers;" blasting with 40 and 60 per cent. gelatine dynamite; and the broken rock was overcast by a Marion No. 40 steam shovel running on standard gage track and operated by compressed air. Owing to the physical conditions, the compressor plant was stationed at a maximum distance of 14,000 feet from the shovel and the drills. In order to keep up the needful pressure, an air receiver was carried on the back of the shovel in addition to its regular boiler capacity; and, furthermore, receivers were placed all along the line at about half-mile intervals. Four-inch standard pipe was used to distribute the operative air to the pneumatic equipment.

Group of "Leyner-Ingersoll" drifters at work in a tunnel heading. The number of machines on the bar is suggestive of the scope of the work involved.

For the first four months, excavating for the road was carried on from the upper end alone, but on the 1st of December a second road crew was started from the lower end, at Hairpin. This crew made much better progress because the slopes encountered were not so steep and the material consisted mostly of earth and decomposed granite which could readily be handled by a steam shovel after comparatively little shooting. With the two gangs working continuously and putting in three 8-hour shifts per day, the eleven miles of road between Camp 33 and Hairpin were completed by May 30, 1922. A total of 226,000 cubic yards of material was excavated, and about 75 per cent. of this was hard granite.

Camps were established at the adit locations as soon as the road got to them; and tunnel operations were begun as quickly as materials and equipment could be hauled and set up. Numbered consecutively from Camp 33 at the intake portal of the tunnel, Camp 34 at Adit No. 1 was reached on October 22, 1921, and Camp 35 at Adit No. 2 on March 15, 1922. From Hairpin, the road to Camp 37 at the tunnel outlet was completed by March 22, and work on the rest of the stretch to Camp 36 at Adit No. 3 was concluded a month later. An accompanying picture of Camp 35 gives a good idea of the rugged nature of the country and of the difficulties contended with in constructing some of the camps so that they might be near the adit portals.

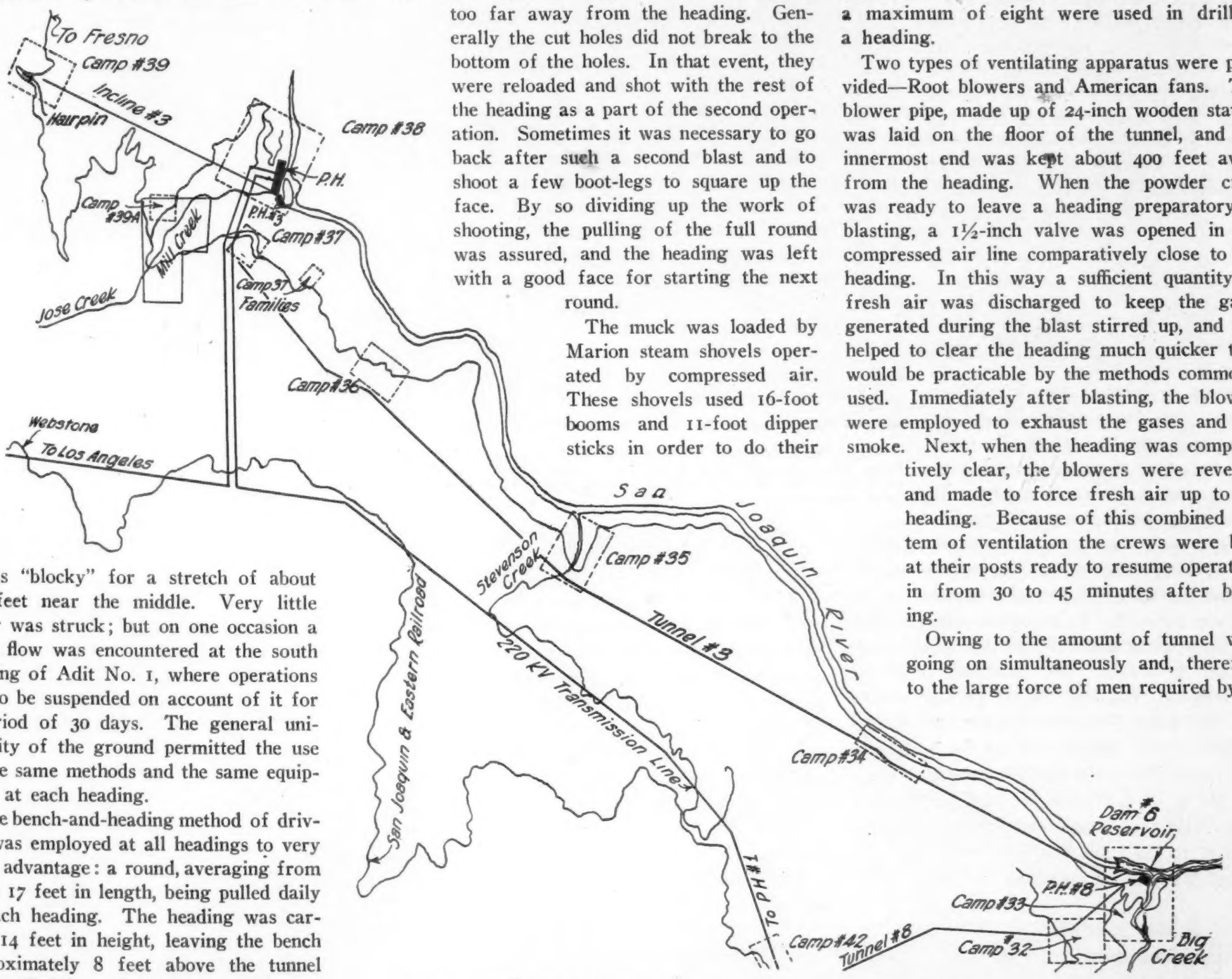
Because Tunnel No. 3 parallels the steep walls of the river canyon, it was possible to divide the tunnel into four sections by means of three short adits—thus permitting the tunnel to be driven from eight headings. The lengths of these four sections, commencing at the



Where Tunnel No. 3 connects with the surge chamber. This picture gives a good idea of the magnitude of some of the passages which have been cut through solid rock.

intake, are: 7,416, 8,693, 7,219, and 4,985 feet, respectively, or a total of 28,313 feet. The adit lengths, in like order, are: 227, 287, and 510 feet, respectively. The tunnel is 21 feet wide and 21 feet high in cross section; it has a square bottom and a rather flat arched roof—the spring line of which is 17 feet above the tunnel floor; it is built on a grade of 3 feet in 1,000; and it has a capacity of 3,000 cubic feet of water per second.

The rock formation through which the tunnel runs is a uniform, hard, gray granite which required no timbering except where it was decomposed for 150 feet at the outlet and where



Map covering the principal topographical and the main engineering features of Development No. 3 of the Big Creek hydro-electric project.

it was "blocky" for a stretch of about 300 feet near the middle. Very little water was struck; but on one occasion a large flow was encountered at the south heading of Adit No. 1, where operations had to be suspended on account of it for a period of 30 days. The general uniformity of the ground permitted the use of the same methods and the same equipment at each heading.

The bench-and-heading method of driving was employed at all headings to very good advantage: a round, averaging from 13 to 17 feet in length, being pulled daily at each heading. The heading was carried 14 feet in height, leaving the bench approximately 8 feet above the tunnel floor. Drilling of the long rounds required the service of 1¼-inch, hollow, round drill steels up to 20 feet in length. The maximum progress for any one heading was made at Adit No. 1, north, where 476 feet were driven in a month—a record for a hard rock tunnel of this size.

The Ingersoll-Rand Company has developed for tunnel driving a special type of drill of sufficient size to warrant the use of steels ranging from 16 to 24 feet in length. The first one of these drills, known as Model X-70, was tried out in Tunnel No. 3, and the results obtained were such as to justify the adoption of this type of drill for the tunnel—in other words standardizing with X-70's. The rock encountered necessitated the drilling of 46 holes in a heading and 30 holes in a bench. For the 13- to 17-foot rounds the cut holes called for steels running up to 20 feet in length. Blasting was done with 40 and 60 per cent. gelatine dynamite and with delay-action electric exploders; but where the rock was exceptionally hard some 80 per cent. powder was put in the bottoms of the holes.

In pulling the long rounds just referred to it was found advisable, on account of the hard rock, to do the blasting in two operations, as follows: the cut holes and the bench holes were pulled together—the muck from the bench serving to smother the rock from the cut holes and to keep it from scattering too far away from the heading. Generally the cut holes did not break to the bottom of the holes. In that event, they were reloaded and shot with the rest of the heading as a part of the second operation. Sometimes it was necessary to go back after such a second blast and to shoot a few boot-legs to square up the face. By so dividing up the work of shooting, the pulling of the full round was assured, and the heading was left with a good face for starting the next round.

The muck was loaded by Marion steam shovels operated by compressed air. These shovels used 16-foot booms and 11-foot dipper sticks in order to do their work effectively within the 21x21-foot section; and under average conditions they mucked a 15-foot round, amounting to 450 cubic yards of loose material, in from 7 to 10 hours. One of our illustrations shows a shovel at work at a heading and also gives a fair idea of the size of the tunnel and the clearances within which the shovel had to operate. Eight-ton, combination-trolley-and-storage-battery locomotives handled the side-dump muck cars. The latter had a capacity of 10 cubic yards and were made on the job.

A large compressor plant was located at each of the tunnel camps to provide operative air. The intake and the outlet headings required about 3,000 cubic feet of free air per minute, while the double headings demanded from 4,500 to 5,000 cubic feet. Both plants, however, were of the same capacity, as compressed air was needed for work other than tunnel driving, and they supplied air at a pressure of 110 pounds. Receivers were located at the compressors and at half-mile intervals within the tunnel. As a result, the pressure was always sufficient at the headings, and work could go on uninterruptedly. Two 4-inch, standard wrought-iron pipe lines conveyed the air to the pneumatic equipment—one supplied the shovel and the other the drills, of which a maximum of eight were used in drilling a heading.

Two types of ventilating apparatus were provided—Root blowers and American fans. The blower pipe, made up of 24-inch wooden staves, was laid on the floor of the tunnel, and the innermost end was kept about 400 feet away from the heading. When the powder crew was ready to leave a heading preparatory to blasting, a 1½-inch valve was opened in the compressed air line comparatively close to the heading. In this way a sufficient quantity of fresh air was discharged to keep the gases generated during the blast stirred up, and this helped to clear the heading much quicker than would be practicable by the methods commonly used. Immediately after blasting, the blowers were employed to exhaust the gases and the smoke. Next, when the heading was comparatively clear, the blowers were reversed and made to force fresh air up to the heading. Because of this combined system of ventilation the crews were back at their posts ready to resume operations in from 30 to 45 minutes after blasting.

Owing to the amount of tunnel work going on simultaneously and, therefore, to the large force of men required by the Southern California Edison Company, it was well-nigh impossible to have at hand a sufficient number of qualified men. As a result, promising men working as chuck tenders were trained on the job and made drill runners as soon as they proved themselves capable of operating a drill. For a while, the shortage of miners was so acute that one heading was turned into a school for drill runners for the other headings. Despite this handicap, progress did not lag; and the tunnel was completed on time, that is, according to the program as outlined for Project No. 3.

The last section of the tunnel was holed through August 1, 1923. A bulkhead was then constructed below Adit No. 2; and just two

weeks later the river was permitted to flow through the upper half of the tunnel for the purpose of washing out the fine muck remaining on the floor. The side walls and the roof had previously been washed down with fire hose taking water from the air line which had been left in place for this purpose. In the meantime, a section of about 300 feet between Adits Nos. 2 and 3 was lined—a Webb pneumatic gun being used to place the concrete. This section and another short length at the outlet end were the only parts of the tunnel that needed lining; and this work was completed on August 26. On September 2, following, the water was turned through the full length of the tunnel to sluice out the floor at the lower end. A 700-foot wooden flume at the outlet served to carry the water away from the penstock and the other structures located there so as to prevent them from being damaged. The concrete plugs at the three adits were all finished on September 4. Then the tunnel was ready for operation.

Owing to delay in the delivery of the cast-steel ring forming the seat of the gate it was not feasible to complete the gate before the flood season of the San Joaquin. This made it necessary to place a heavy timber bulkhead across the entrance to the tower in order to hold back the water in the reservoir pond and to allow the gate to be erected as soon as the ring seat arrived. As it turned out, the gate was put in place with the reservoir pond standing full of water. The bulkhead, made up of 12x12-inch timbers, was practically watertight: the small amount of leakage that had to be handled was taken care of by a 24-inch drain leading from the intake structure through Dam No. 6. This drain is provided for the purpose of allowing enough water to pass through the dam to maintain fish life below the site without the need of operating the large sluice gates.

The intake structure was in working order by August 23, 1923, except for the removal of the timber bulkhead. By the time the rest of Project No. 3 was ready for service, the entire flow of the river could be carried through the dam by the four sluice gates. This made it possible to drain the reservoir and thus to remove the temporary bulkhead at the intake tower without water interference.

(To be continued).

Intake tower for Tunnel No. 3 rises to a height of 100 feet from the base of its foundation. The tower makes it possible to control the flow of water entering the tunnel from the adjacent reservoir.

NEW SLIDE RULE GREAT HELP TO DRAFTSMEN

WHENEVER in any given line of manufacture it is necessary to make articles of a considerable range of sizes, the work of preparing drawings is made irksome by the necessity of referring to rather complicated tables and diagrams. In preparing detail and assembly drawings from such diagrams and tables, mistakes are frequently made either by taking values from the wrong column or by selecting the wrong reference letter in the diagram.

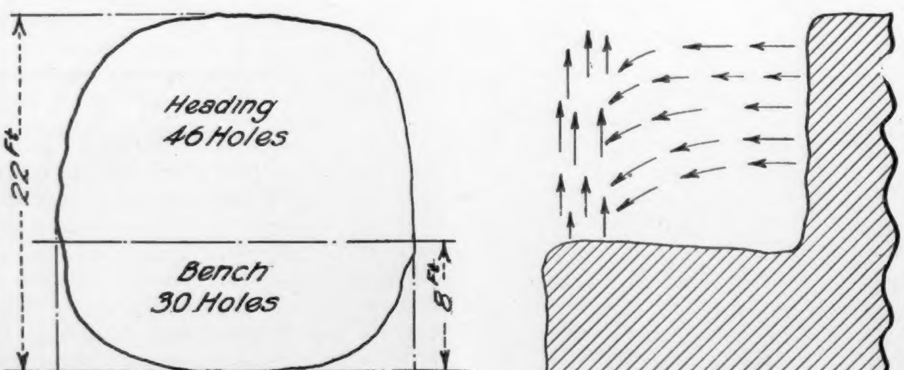
The American Engineering Standards Committee has called attention to a newly developed slide rule for standard parts, which was recently put on the market in Switzerland and was exhibited at the International Standardization Conference at Zurich. By use of this novel aid the chance of making mistakes in transferring standard dimensions to drawings and computations is practically eliminated; and, furthermore, the slide is referred to much more quickly and conveniently than the usual tables of standard parts.

The slide rule presents all essential dimensions for the full series of Swiss standard bolts, nuts, and washers; and by so moving the slide that the desired diameter of a bolt, for instance, appears through a "window" or opening in the fixed part of the rule, all the dimensions for the other parts of that bolt are given in corresponding rectangles on a diagram of the bolt, which is engraved on the fixed part of the rule. In this way, each dimension is found in exactly the place where it applies. For example, the diameter of a certain washer appears just where the washer would be dimensioned on any drawing incorporating the combination of bolt, nut, and washer.

In addition to the fundamental dimensions of the bolt, itself, the rule offers a convenient means of showing the diameter of the drill that is needed for drilling the threaded hole to receive the bolt; the diameter of the cotter pin to be used; the effective cross-sectional area of the bolt in square inches; its safe carrying capacity in pounds; and the working stress at that load in pounds per square inch. Besides, the rule carries, on the reverse side, a similar presentation of the dimensions of two other standard-design components—shaft keys, and gas pipes.

This novel slide rule certainly serves to illustrate one of the advantages of standardization, which should be adopted where practicable in an effort to bring about manufacturing economies. It is adaptable wherever standard dimensions have been determined upon for parts, components, or complete machines.

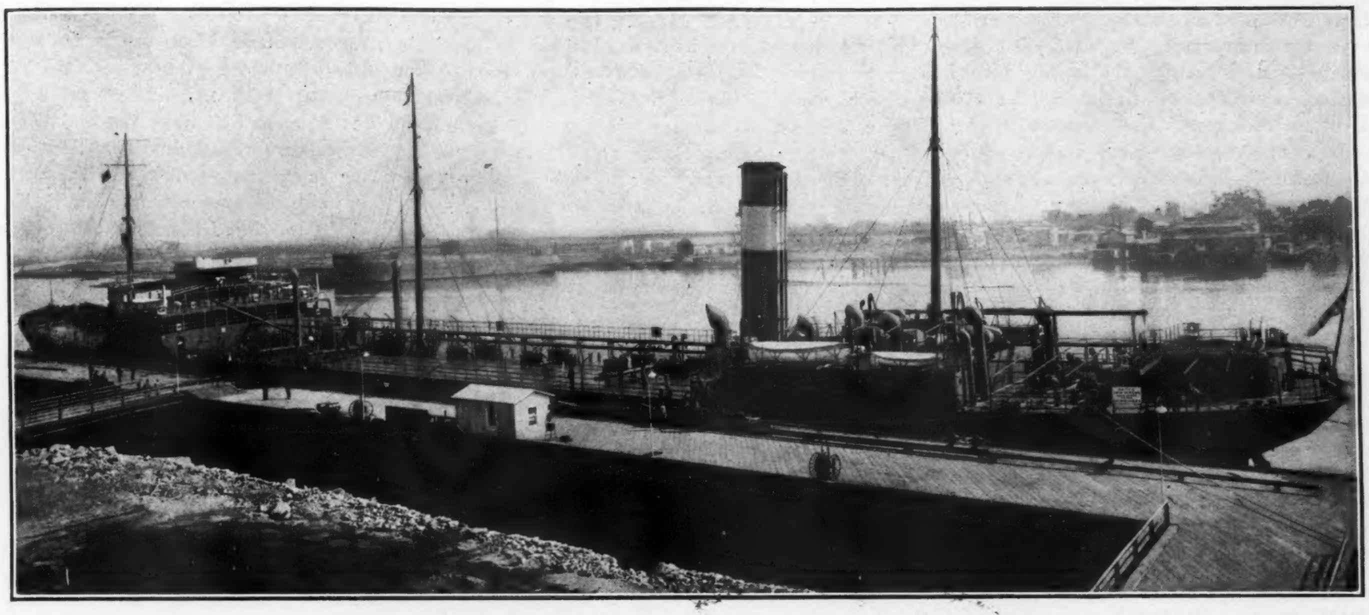
When a fellow can find nothing else to do he can turn his hand—or his head—to inventing. The United States Patent Office has recently been receiving patent applications at the rate of 9,000 per month. The records show that in times of business depression the number of applications filed is much greater than in times of industrial prosperity.



By firing bench and heading holes at the same time, the bench rock thrown vertically arrests the rock projected horizontally from the heading. This interference brings all the rock down into a single pile which can be conveniently mucked and, incidentally, forms the pile where it will not interfere with the resumption of drilling at the newly exposed faces.

Making Another World's Record

By H. G. CONKEY



Great tanker "John D. Archbold" at the dock of the Petroleum Midway Corporation, Ltd., where she loaded 143,290 barrels in the record-making time of 5 hours and 41 minutes. This was rendered possible by the centrifugal pumps installed in the plant.

PETROLEUM from the California oil fields has latterly represented 60 per cent. of the total eastbound cargo carried through the Panama Canal. And some idea of the actual volume of this important traffic can be gathered from the fact that in the course of a single week of the present year as many as 1,356,000 barrels of crude and refined oil have been transported from the West coast to domestic ports along the Gulf of Mexico and the Atlantic seaboard.

To meet the demands of this department of the American oil industry there is employed a fleet of ocean-going tankers especially designed for the service; and to utilize this aggregation of ships economically it is essential that they be kept underway as much as possible. To accomplish this it is necessary that their lay-over periods be brief and that their turn-round be effected with all practicable dispatch. This means, of course, that loading and discharging must be done quickly.

On January 28 of this year, a world's record was made in loading a large tank steamer at the station of the Petroleum Midway Corporation, Ltd., in the harbor of Los Angeles, Cal. On that day, the ocean-going tanker *John D. Archbold* had 143,290 barrels of oil put aboard of her in the course of 5 hours and 41 minutes—that is, at an average rate of 25,212 barrels every 60 minutes. The peak of this performance was reached when the big pumps of the loading station discharged oil into the tanks of the steamer at a rate of 28,350 barrels an hour.

It might be of interest to tell something about the equipment of the plant that made this loading record possible. The Los Angeles station of the Petroleum Midway Corporation, Ltd., is provided with two pump houses in each of which there are installed three Cameron single-stage, double-suction, volute pumps. Each pump is direct connected to a 200-H.P. General Electric motor and is designed to handle 3,500 gallons per minute of crude oil against a pressure of 60 pounds—the oil being

Left—In this pump house are three Cameron pumps each capable of handling 3,500 gallons of heavy crude oil per minute at a pressure of 60 pounds. Right—Part of the plant of the Petroleum Midway Corporation, Ltd., at Los Angeles, Cal.

of 24° Baumé and having a viscosity of 200 at 70°F. The arrangement is such that the oil flows by gravity from storage tanks to the pumps and is then relayed by the latter to the ships at the dock. In making the record in question only four of the six pumps were used, and these worked at an average pressure of 45 pounds to the square inch.

Until the 28th of January, the loading record for tankers was held by the station of the Standard Oil Company, also situated in the harbor of Los Angeles. That station, eight months previously, had loaded a ship at the rate of 22,500 barrels an hour. The time taken by the station of the Petroleum Midway Corporation, Ltd., in loading the *John D. Archbold* was officially checked, and, as the figures show, bettered the preceding record by 2,712 barrels an hour.

The *John D. Archbold* is a sister ship of the *William Rockefeller*. These vessels are the largest in the Standard Oil Company's fleet of tankers, and each has a rated capacity of 140,000 barrels.

STEAM POWER FROM EARTH PUT TO USE

At Devil's Gulch, Sonoma County, California, there are two drilled wells which deliver steam that is being used in steam engines to generate electric current for light and power. A third well, half a mile distant, is now being drilled, and it is expected to supply the town of Healdsburgh, lying 23 miles away, with sufficient current for lighting and heating. It is confidently estimated that the well will have a capacity of 2,500 H.P.

The subterranean reservoir from which the steam issues is supposed to be ten miles long and half a mile wide. It will be remembered that if the volume of steam be sufficient the pressure need be but little above that of the atmosphere, as the condenser may serve to produce the necessary vacuum to induce an effective pressure of ten pounds or more.

WHO WANTS SOME RADIUM?

What to do with petroleum was a problem when oil was struck in Pennsylvania before the Civil War, and now we seem in a fair way to be equally puzzled about the disposition of radium, which is being obtained in quantities that exceed the world's demand. It is not likely to be much cheaper, however, on account of the cost of production. At the new reduction plant for Katanga radium ore at Oolen, near Antwerp, Belgium, the monthly output is said to be about the size of an ordinary lump of sugar. The ore, though the richest in radium of any yet discovered, contains only 1 part of radium to from 10,000,000 to 20,000,000 parts of gangue, which latter contains uranium, copper, lead, iron, etc. The concentrate, after a long series of chemical reductions, is a small amount of barium salts containing 1 part of radium to 125,000 of salts.

ENGINEERS SOCIETY HOLDS ANNUAL BANQUET

The twenty-seventh annual banquet of the Engineers Society of Northeastern Pennsylvania, held at the Hotel Sterling, Wilkes-Barre, Pa., on Wednesday evening, February 6, was a very enjoyable meeting for the more than 500 members and their friends who attended.

This society was organized in 1893 as the Scranton Engineers Club and was incorporated in 1894. Articles of incorporation set forth that the club was "formed for the advancement of engineering in its several branches and for the professional improvement of its members." The continued growth of the club and the extension of its field of activities led, in 1911, to a change in the corporate name to the Engineers Society of Northeastern Pennsylvania.

Shelby D. Dimmick, president elect of the Engineers Society of Northeastern Pennsylvania.

Active membership in this influential and progressive society is confined to those following one of the various engineering professions or whose business embraces engineering or other scientific work. Today, there are found on its rolls and among those directing its affairs the leading engineers and executives in that section of the state.

The annual dinner is always a matter of considerable interest, not only to its members and to those in the profession but to business men generally, because of the society's well-known policy of having speakers of national reputation address these meetings. This year, by request, arrangements were made with station WBAX to broadcast the entire program.

The meeting was opened with an address by the retiring president, William Wilhelm of the Ingersoll-Rand Company, who reviewed the history and the purposes of the society. He spoke of the broadening of the engineering profession and of how that expansion has led to specialization in relatively limited fields with the result that, today, the names of the various kinds of engineers are almost legion. Mr. Wilhelm called attention to the great loss suffered by the society during the past year through the death of several prominent members, among whom were Captain W. A. May, president of the Pennsylvania Coal Company and a charter member and past president of the Engineers Society; Mr. Philip Weiss, district manager of the Ingersoll-Rand Company, one of the society's oldest members; Mr. William Griffith, one of the best-known mining and metallurgical engineers in the state; and Mr. W. L. Connell, prominent coal operator and for years chairman of the Conciliation Board between Anthracite Miners and Operators. He then introduced Mr. George Stevenson, well-known consulting engineer and authority on coal mining properties, as toastmaster of the evening. Speeches followed by Mr. Shelby D. Dimmick, vice president and general manager of the Glen Alden Coal Company and president elect of the society for the coming year, and by David J. Davis, lieutenant governor of Pennsylvania.

The speaker of the evening was Mr. Francis H. Sisson, vice president of the Guaranty Trust Company of New York City, a widely known authority on financial matters and a contributor to the financial pages of many of the leading newspapers and magazines. Mr. Sisson fully justified his reputation as one of the most eloquent and convincing after-dinner speakers in public life today, and he held his hearers in rapt attention. Mr. Sisson's address consisted of an analysis of existing domestic conditions and of the opportunities for industrial and commercial development. He showed, however, that such development is closely linked with and dependent on the unhampered operation of our railway systems. He plead for more consideration for the railroads, and asked that the Esch-Cummings act be given a fair trial. He pointed out that, handicapped as the railroads are by changing federal and state control, capital—much needed for development and betterment—is being driven away from them to the less-supervised industrials, where the returns are greater and more certain.

Iron Mining in Northern Africa

By A. GRENON

Sample of the hematite mined at Djebel-Djerissa.

ALGERIA and Tunis are notably rich in deposits of iron ore. In fact, some sections of these two countries, in the matter of their mineral wealth recall certain well-known districts in the United States and in Australia. In the western part of Tunis, within a zone having a diameter of twelve miles, there are three iron mines, three phosphate mines, two lead mines, and one zinc mine undergoing energetic operation. The principal iron-producing centers of Algeria and Tunis are estimated to hold a possible yield of more than 250,000,000 tons. The ore is rich and of excellent quality, and is valued highly in France, Germany, and England, to which countries it is mainly exported.

The iron mines at Djebel-Djerissa, which we are about to describe, are a part of the activities of the famous "Compagnie des Minerais Magnetiques de Mokta-el-Hadid," which is the oldest of the mining companies of northern Africa—having been in the field since 1865. The Djebel-Djerissa property has been worked since 1908. It is situated 125 miles southwest of Tunis, on the Algerian border; and its annual output is said to average 400,000 tons.

The ore bed is striking evidence of the manner in which the crust of the earth in that region was disturbed in ages gone when the Urgonian division of the lower cretaceous limestone formation was pushed surfaceward through the superposed cretaceous formation which constitutes generally the surrounding leas and uplands of this part of Africa. An accompanying sketch shows the disposition and the form of the iron-bearing vein, which has a thickness ranging from 40 to 50 feet and an outcrop area at the surface of substantially 20 acres.

The deposit is worked by the open-cut or stripping method; and both the ore and the limestone overburden are hard. Operations are carried on in a series of steps between altitudes of 2,300 feet and 2,850 feet above the sea. As the ore is removed, the mountain is gradually being cut away, and in time this mass will be leveled. Over 5,000,000 tons of ore and an equal amount of limestone have already been handled.

The ore, which is a hematite, is of the following composition:

Iron, when dry	55 to 63	per cent.
Manganese	2 " 3	" "
Silica	1 " 1.5	" "
Lime (calcium)	3 " 4	" "
Phosphorus, not more than	.013	" "
Arsenic	0	

The motive-power plants are grouped at the base of the mountain. Operative compressed

Above—Native workmen have taken very kindly to American rock drills which have greatly lightened the task of mining iron ore in northern Africa. Right—Another American mechanical invention which has helped to revolutionize iron mining in Tunis.

Village of Djerissa with office of mining company on the crest of the slope to the left.

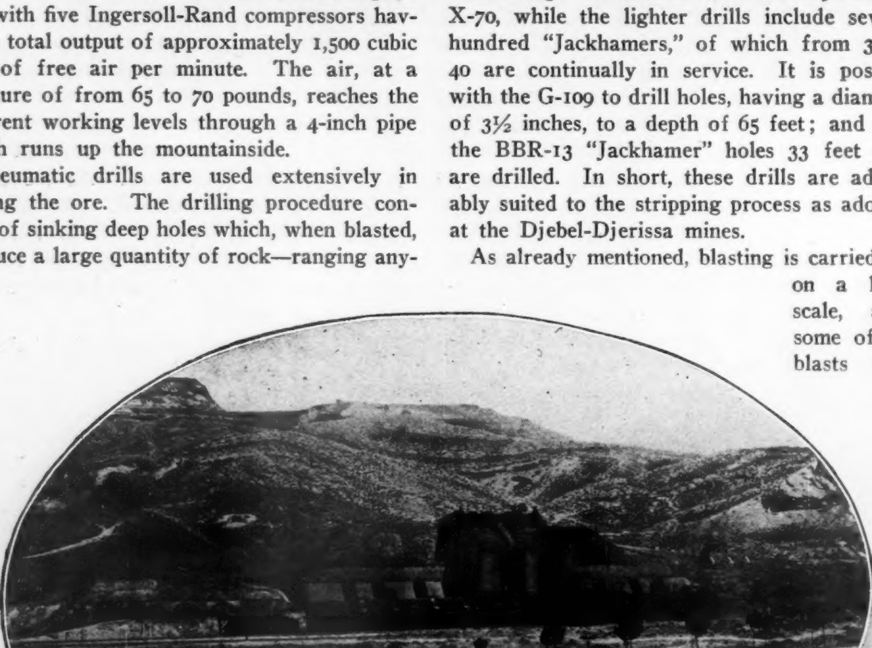
air is distributed from a central station equipped with five Ingersoll-Rand compressors having a total output of approximately 1,500 cubic feet of free air per minute. The air, at a pressure of from 65 to 70 pounds, reaches the different working levels through a 4-inch pipe which runs up the mountainside.

Pneumatic drills are used extensively in mining the ore. The drilling procedure consists of sinking deep holes which, when blasted, produce a large quantity of rock—ranging anywhere from 300,000 to 350,000 cubic feet. Owing to the fact that some of this rock is in large pieces it is necessary to break up these masses so that they will be of a convenient size for subsequent handling. To effect this, what is known as pop holing is resorted to—that is, one or more holes are drilled with a "Jackhamer" in each piece of limestone, and these are charged with explosive and blasted. The excavated ore is broken up by air-driven paving breakers, type CC-25.

The larger drills used are the G-109 and the X-70, while the lighter drills include several hundred "Jackhamers," of which from 35 to 40 are continually in service. It is possible with the G-109 to drill holes, having a diameter of 3½ inches, to a depth of 65 feet; and with the BBR-13 "Jackhamer" holes 33 feet deep are drilled. In short, these drills are admirably suited to the stripping process as adopted at the Djebel-Djerissa mines.

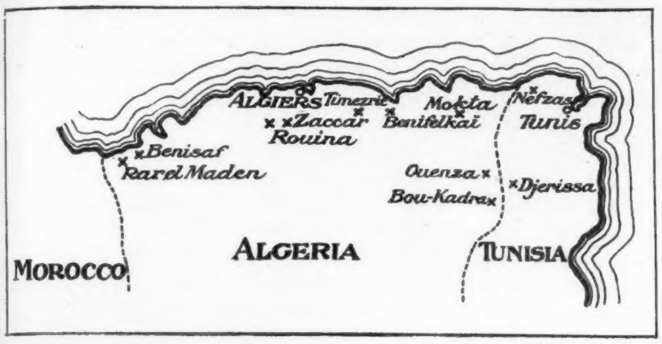
As already mentioned, blasting is carried out on a large scale, and some of the blasts have been notable. For example, in 1921—with 20 vertical holes, each 3¼ inches in diameter and 60 feet deep, and with 20 horizontal holes, each 1½ inches in diameter and about 24 feet in depth—as much as 280,000 to 320,000 cubic feet of material was blasted out at one time. Those performances represented the breaking up of from 16,000 to 18,000 tons of rock and ore. In each 60-foot hole there was placed a charge of 88 pounds of dynamite. Again, during 1923, 6,600 pounds of dynamite were used to blast out 24,000 tons of rock. In that case there were 21 vertical holes, each 55 feet deep, and 30 horizontal holes, each 23 feet deep. Expressed in another way, for each foot of hole there was produced 13 tons of rock, or more than 3.6 tons of rock for each pound of explosive.

The drill steels are of 1½-inch octagonal steel, with cross bits. The steels are handled by means of a hoist mounted on a derrick which also carries the rock drill. When the

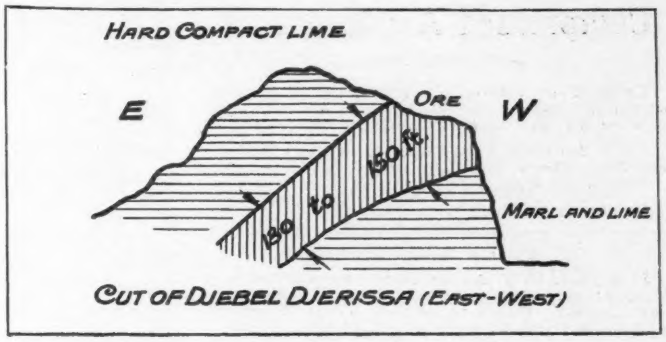


General view of the iron deposits at Djerissa.

On the slope of the mountainside at an altitude of 2,650 feet above the sea. This is the head of the inclined plane by which the ore is carried down to the railroad which runs to the coast.



Algeria-Tunis section of northern Africa.



Geological formation at Djebel-Djerissa mines.

total length exceeds 45 feet, the drill steels are assembled by means of screw joints. The steels for the hammer drills are made from 15/16-inch hollow, round steel and have cross bits.

Because of the location of the mines, the entire work is strictly localized: the limestone is thrown behind the mountain while the ore is carried down to the bottom of the slope by shafts. Steam shovels, mounted on caterpillar tractors, are employed to handle both the ore and the limestone. The ore is dumped into metal cars by a rapid-loading installation and transported by rail to the harbor of La Goulette, near Tunis, 133 miles from the mines. At the port, facilities are provided which make it practicable to load the ore aboard ships at the rate of 12,000 tons every 24 hours.

American engineers and capitalists are considering the practicability of building a tunnel under the St. Lawrence, at Montreal, and are making the preliminary arrangements for its construction. This is becoming quite essential to relieve the congestion on the Island of Montreal and to provide new and adequate means for reaching and spreading out along its southern shore.

ROUGH GOING NO OBSTACLE TO THIS PORTABLE

THE accompanying photograph is evidence enough that the day has arrived when portable compressors are really portable. Here we have an Ingersoll-Rand 8x8-inch Type Fourteen machine being pulled by a tractor to Keno Hill, Alaska, over very rough country.

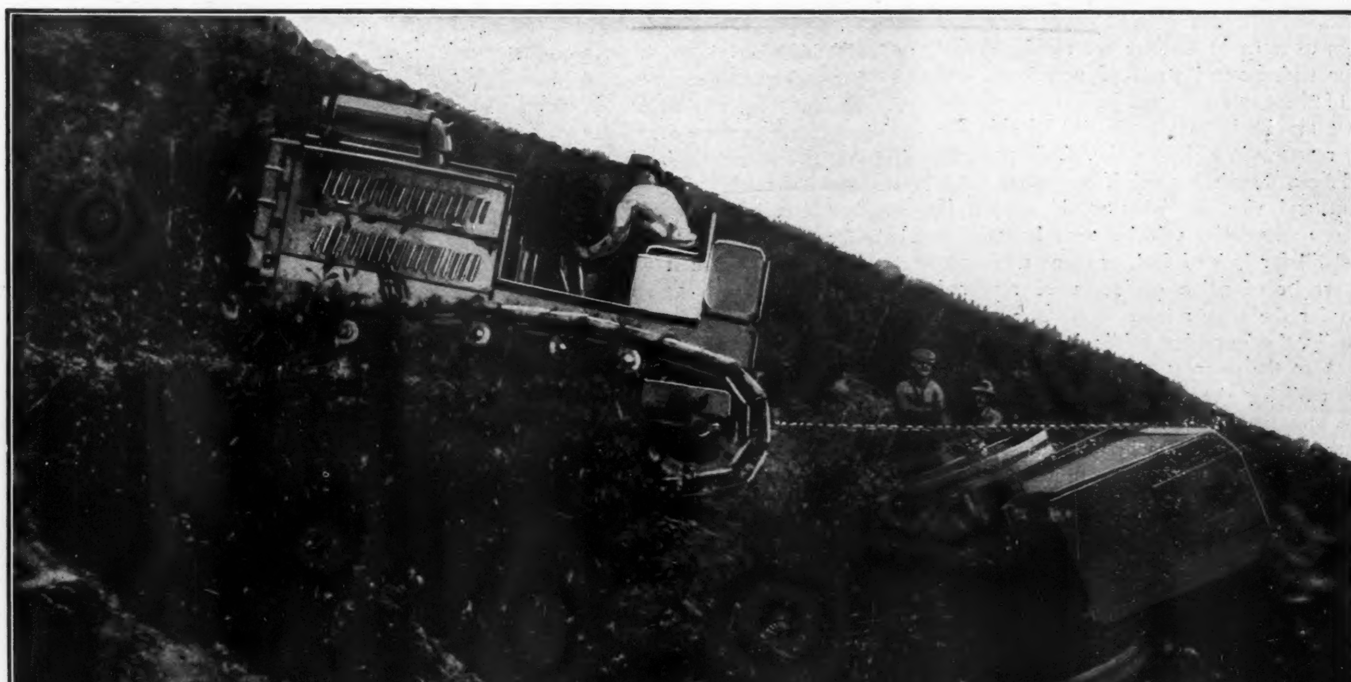
This machine was expressed in 1922 from Painted Post, N. Y., to Seattle, Wash., where it was loaded on board ship and taken to Bethel, Alaska, at the mouth of the Kuskoquim River. There it was put on a barge and carried up the river to McGrath, where it was used by the Treadwell Mining Company for approximately a year.

When the Treadwell properties at McGrath were closed, and the company took over its present holdings at Keno Hill, this machine was moved overland to the Yukon River, placed on a barge, and thus transported to Stewart, whence it continued up the Stewart River to Mayo Landing. From Mayo Landing it was hauled by team and tractor a distance of 50 miles to its present location at Keno Hill, where it is still in service.

This portable has traveled a distance of nearly 10,000 miles. We believe that during some stages of its journeying the compressor has encountered rougher going than has yet been experienced by any other machine of like character.

The fact that the direct-connected gasoline engine and the air compressor are mounted on a solid, 1-piece, cast-steel frame explains why the unit was not twisted out of alignment in transit.

A string of tools, stuck in a hole 6,280 feet deep since September, 1923, has just been fished out near Ligonier, W. Va.,—a novel fishing device being employed for the purpose. The string, 50 feet long, was held fast by a cave-in. A drill-mill was let down around the tools; the debris which held them was milled away; and the tools were hooked onto a line and lifted out. Such ready skill and unconquerable perseverance the world does not often hear about. The test hole will now be sunk deeper, and it is expected that another hundred feet or so will bring the desired results.



Despite the fact that this portable compressor had a tumble and encountered much rough going on a long journey, still it was fit for service when called upon to furnish air for rock drills, etc.

Compressed Air Magazine

—Founded 1896—

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EDITORIALS

POSTPONING THE DAY OF OIL SHORTAGE

STATISTICS are offered every now and then to warn us that we are rapidly draining our underground pools of petroleum, and some of the experts do not hesitate to declare that we are likely to see the end of this domestic resource in a short while. This prospect should be a disquieting one if we pause for a moment and visualize what would happen if 15,000,000 automotive vehicles were brought to a standstill for lack of fuel, or many thousands of internal-combustion engines were rendered useless for the same reason.

Happily, the hastening public does not worry much about the morrow, and a fair percentage of us—realizing the marvels that the man of science and the inventor have achieved—complacently remark: Oh, why bother? Something will be done to solve the problem before the day of shortage arrives. While this is a dangerous attitude, and one that imposes disappointments and rude awakenings now and then, the outlook for an abundance of liquid fuel is far more favorable than might be imagined. Indeed, means have been devised by which low-grade coals and other carbonaceous raw materials can be made to furnish liquid fuels suited to many fields of service. Once more we see how the well-nigh forgotten researches of men that have passed away can be given present-day value by utilizing them in combination with modern facilities of production.

As far back as 1849, PIERRE E. M. BERTHELOT, a noted French chemist, discovered that coal, when heated in sealed tubes to a temperature of 536°F. for twenty hours in contact with hydriodic acid, would yield a heavy oil. Afterwards, other men of the laboratory showed how organic substances of various sorts could be made to produce hydrocarbons when subjected to hydrogenation. Recently, Doctor BERGIUS, a German scientist—building upon the disclosures of the earlier workers in this field—has developed a process by which coal can be liquefied and made to furnish a wide range of hydrocarbons. A plant for this purpose has been established at Mannheim, and the activities there are attracting a great deal of attention on the part of the engineering world.

A Belgian commission has lately reported upon what it saw at the Mannheim works. Among the findings of the commission—according to the *Iron & Coal Trades Review*—is the following suggestive paragraph: "The BERGIUS process permits the production on a commercial scale of oils for which the country is at present dependent on foreign supplies. The raw materials used are those of which considerable quantities are found in the country. The application of the process in Belgium, therefore, becomes a matter of primary national importance. The process can furnish large quantities of home-produced benzol."

If the BERGIUS method for the liquefaction of coal be all that is claimed for it, then the people of the United States need not worry, because we have an abundance of raw materials which can be converted by this process into liquid fuels and other products now obtained principally from petroleum.

AMERICA AS A PRODUCER OF SILVER

OUR MINES yielded in 1922—the last year for which complete data is at present available—more than a quarter of all the silver taken throughout the world from the earth during that twelvemonth. To be exact, the output was approximately 26 per cent. of the total, and this has been exceeded by the domestic industry only twice in the course of its history, namely, in 1870 when it was 29 per cent. and in 1900 when it was 33 per cent.

The National City Bank of New York has recently made a survey of this field of endeavor and has disclosed some interesting facts that are not matters of common knowledge. It is doubtful if the general public realizes that next to Mexico the mines in the United States furnish the world with a larger percentage of silver than do the deposits of any other country. It seems that our output of silver prior to 1860 amounted to but a fraction of 1 per cent. of the world's production, but in 1860 it jumped to 5 per cent. with an outturn of 116,016 ounces. In 1870 our mines yielded 13,000,000 ounces or 29 per cent. The records for the next four decades are as follows: 30,000,000 ounces in 1880; 54,000,000 ounces in 1890; 58,000,000 ounces in 1900; and 57,000,000 ounces in 1910. During 1915 the output was 75,000,000 ounces, and in 1922 the domestic mines supplied 56,000,240 ounces of the precious metal. The crest was reached in 1915 because our activity in this field of mining increased as it fell off elsewhere owing to the war.

According to the report made by the bank: "A very considerable share of the new silver produced from year to year is now used for purposes other than monetary. Some of it is lost by abrasion, some of it passes to the Orient and disappears in the 'hoards' characteristic among the people of that part of the world. Much of it has been used for years in the manufacture of tableware, ornaments, and toilet articles; and of late large quantities are utilized in photography—especially in the thousands of miles of motion picture films annually turned out in the world. . . . A recent statement by a high authority puts the quantity of silver now in use in photography and silver plating at from 10,000,000 to 20,000,000 ounces a year, while from 20,000,000 to 30,000,000 ounces are annually used in the manufacture of tableware, toilet articles, etc. Accepting the higher of these figures, it would appear that about one-fourth of the world's silver production is now used in the arts and the industries."

Admitting that the silver worked into tableware, ornaments, and toilet articles may be recoverable when needed, it is undoubtedly true that only a small fraction of the silver employed in photography is now reclaimed. Something has been done in this direction, but the results compared with the consumption are relatively negligible. Fifty years ago no one probably visualized the extent to which photography and one of our popular sources of amusement would be dependent upon the mining of silver.

AMPLIFYING OUR DIET

WITH tomatoes and asparagus reaching us from Chile; with Argentina sending us grapes, peaches, and plums; and South Africa providing us with luscious melons and other delectable fruits, it will probably not surprise us when, in the near future, we find reindeer meat from Alaska in the butcher shops of our Atlantic seaboard communities as well as elsewhere throughout the length and breadth of the country.

It was only a few years back that the reindeer herds of Alaska were of very modest proportions, and the future of that industry was fraught with many uncertainties. In the interval, thanks to the enterprise and the intelligent management of the persons most concerned, the herds have steadily increased in numbers until their perpetuation can be counted upon with reasonable confidence and their multiplication relied upon to provide us with a new source of succulent foodstuff.

The effective and economical distribution of reindeer meat will, in large measure, depend upon the establishment of suitably capacious refrigerating plants near the source which will freeze the flesh so that it can be transported long distances and be delivered to the ultimate consumer in prime condition. The dressed carcasses weigh 125 pounds apiece; and the price delivered at the Atlantic seaboard is at present only a little higher than prime cuts of beef

from live stock raised south of the Canadian border. With improved facilities for the handling of the commodity, reindeer meat, which is said to be fully equal in flavor to that of venison, should be available anywhere within the United States at a cost not exceeding the prices commonly charged for beef, veal and lamb.

The reindeer is a prolific breeder, and if no more than 10 per cent. of the young steers are killed and marketed annually—as recently provided for by law—the herds will be capable of renewing themselves every three years, so it is said. One man can look after a very large herd—showing how tractable the animals are under domestication. It should be pointed out that the economic value of the reindeer is not confined to its usefulness as a source of food.

Our fellow citizens in Alaska have developed the reindeer industry despite heavy odds; and in time the people at large will realize their indebtedness to the courage and the foresight of these pioneers.

GONE UP IN SMOKE

LAST year our tobacco industry turned out 7,000,000,000 cigars—enough of them to provide every male citizen of smoking age in the country with 4½ boxes of the "weed." Assuming 50 cigars in a box, these containers if set end to end would have a total length of 20,000 miles!

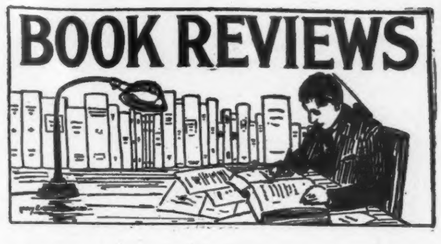
The manufacture of cigars was begun in this country something like 125 years ago, and today the industry makes annually products valued at about $90,000,000. According to the last census, there were 10,000 cigar factories within our gates; and in these plants—representing more than $200,000,000 of capital investment—work was given to substantially 136,000 wage earners.

According to a recent report of the National Bank of Commerce: "The cigar industry employs nearly three times as many people as the aggregate number employed by all other branches of the tobacco manufacturing industry. Recently, machines have been perfected for manufacturing cigars at a capacity rate of 480 per hour. More than 600 of these were in use in 1922. The introduction of improved automatic machinery for making cigars will no doubt effect great economy as hand labor has heretofore constituted such a large part of the cost of manufacture."

Continuing, the same authority informs us that, "By far the greater part of the tobacco used in the United States for the manufacture of cigars is raised in this country, as soil and climatic conditions are favorable for the production of types of leaf suitable for every form of consumption."

The good souls that would taboo tobacco should heed the foregoing facts and figures and realize what an economic disturbance would follow if the growing, the manufacture, and the use of tobacco were prohibited.

On the Southern Pacific Railroad, passenger trains made up of as many as twelve cars are being run between El Paso and Los Angeles—a distance of 815 miles—without change of engines. Various grades, up to 2 per cent., are encountered.



MARINE PRODUCTS OF COMMERCE, by Donald K. Tressler, Ph.D. A generously illustrated volume of 762 pages, published by The Chemical Catalog Company, Inc., New York. Price, $9.00.

AT THE very start, the author says that the book is intended for both the scientific and the practical man. This is substantiated in the succeeding pages. In addition to giving the chemist and the biologist a general survey of the fishery industries—pointing out their relative importance, indicating their location, and describing the methods in common use among them—much is said in simple, lucid language to hold and to fascinate the layman.

Doctor Tressler tells us that "the sea covers three-fourths of the earth's surface, and is so vast that few can comprehend its size, being about 139,000,000 square miles in area and 302,000,000 cubic miles in volume. To the casual observer the ocean appears as a barren waste valued chiefly for transportation and source of rainfall. Yet it is veritably teeming with both plant and animal life. The largest animals and the tallest plants grow in the ocean. Nowhere else can such large quantities of excellent food be obtained for so little effort."

This work is unhesitatingly commended to anyone seeking information and entertainment the while; and in various ways the book fills a long-felt want.

BLASTING WITH HIGH EXPLOSIVES, by W. Gerard Boulton. An illustrated volume of 108 pages, published by Isaac Pitman & Sons, New York. Price, $1.50.

MANY persons still use black powder for blasting purposes mainly because they are unacquainted with the superior merits of modern high explosives. Mr. Boulton has prepared a handy little book of enlightenment which should be acceptable to mining engineers and to others that have to make use of explosives for such purposes as quarrying, removing wrecks, breaking rocks under water, destroying buildings, clearing the ground of tree stumps, etc.

The author describes the different kinds and types of commercial explosives, fuses, and exploders, and he likewise gives clear and careful instructions regarding the method of preparing and the laying of charges for different classes of work. This book should prove especially helpful to the so-called practical man.

PROFITABLE MANAGEMENT, by J. Lee Nicholson, C.P.A. A book of 117 pages, published by The Ronald Press Company, New York. Price, $1.25.

THE CAUSES leading to business failure have been investigated by the Federal Trade Commission; and that body reported a few years ago: "Of 250,000 manufacturers in the United States, 125,000 (50 per cent.) operated without profit; and only 12,500 (5 per cent.) had exact knowledge of the costs of their products."

The commission advanced the opinion that the 125,000 businesses were operated without profit because they were without adequate methods for ascertaining the cost of the goods they produced. Mr. Nicholson has set himself the task of blazing a path through an underbrush of guesswork, approximations, and chance so that responsible executives could have the way cleared for them and be able to visualize their problems understandingly and with a positive grasp of facts essential to business success. This book should prove of material aid to thousands of persons entrusted with administrative responsibilities.

ADVERTISING AND SELLING, edited by Noble T. Praigg. This book of 483 pages is published by Doubleday, Page & Company, Garden City, Long Island, N. Y. Price, $2.00.

THE BOOK is a collection or rather digest of the leading addresses made during the Nineteenth International Convention of the Associated Advertising Clubs of the World, held in Atlantic City, N. J., in June of 1923. As can readily be imagined, the topic matter ranges all the way from how advertising touches human interests to advertising as an arm of industry. Incidentally, many aspects of this steadily widening field of service are dealt with, and much is told which should be both an inspiration and a guide to men in the advertising business as well as to those who contemplate taking it up as a life work.

THE UTILIZATION OF LOW-GRADE AND WASTE FUEL, by W. Francis Goodrich, M.B.E. A work of 368 pages, containing 44 tables and 212 illustrations, published by Ernest Benn Limited, London, England. Price, 42 shillings.

THIS VOLUME is a welcome contribution to a vitally important economic problem, because it deals with the methods employed and the results obtained in using many fuels which have heretofore been generally regarded as worthless, unsatisfactory, unmarketable, and inefficient because of their relatively low calorific value.

Mr. Goodrich reveals that this attitude has been a wrong one or at least has become untenable owing to mechanical developments and researches which have made it practicable to utilize many of these fuels effectively. As he remarks: "The conservation of coal is a many-sided and complex problem;" and he emphasizes that the solution does not lie in confining effort merely to the more efficient use of high-grade fuels. It is self-evident, as the author discloses, that the whole world is pretty much concerned in obtaining heat and power in large measures from so-called low-grade and waste fuel.

As a result of recommendations made at a conference of manufacturers, distributors, technical societies, and consumers, held under the auspices of the Division of Simplified Practice, nearly one-third of certain styles and sizes of forged tools now produced are to be eliminated. In other words, out of a total of 549 such tools but 365 are henceforth to be retained by the manufacturers. The simplified program adopted goes into effect on July 1.

The manufacture of ice is ninth in the list of leading industries in the United States.

COMPRESSOR EXPLOSIONS EXPLAINED

MENTION was made in the October, 1923, issue of this Magazine of an informative paper on *Explosions in Air Compressors* prepared by J. A. Vaughan* and read during the March, 1923, meeting, at Johannesburg, of the South African Institution of Engineers. This paper has created such world-wide interest among compressed air users that a more comprehensive review is warranted.

As previously stated, the paper is built up around the fact that during the last sixteen years, in the Union of South Africa, there have been sixteen official inquiries by the Department of Mines and Industries into the circumstances attending explosions or firings among the compressed air systems of mines in the Transvaal. Ten of these cases were explosions, while in the other six cases there were only burnings in the pipes or passages through which the gases passed. Accidents such as the bursting of pipes or receivers, due to inherent weaknesses or the closing of valves, are not considered.

It is pointed out that the amount of oil used for internal lubrication of the air ends of compressors is not sufficient to form an explosive, gaseous mixture even when lubrication is carried to pronounced excess. Improper lubrication of the air cylinders is, however, the cause of carbonaceous deposits, which are the seat of all trouble. The use of a very viscous oil results in a greater quantity being required to cover the internal surfaces of the air cylinder than would be needed if a more fluid oil were employed. Further, owing to its sluggish nature, it collects and amalgamates with particles of dust—invariably present in the air being compressed—and rapidly forms into a hard deposit, principally carbon, which clogs the piston rings and valves. Heavy cylinder oils, because of their viscid nature, encounter difficulty in getting out of the cylinder, thereby being exposed to the drying action of hot compressed air longer than necessary. This results in a heavy deposit of carbon on the valves and in the discharge passages.

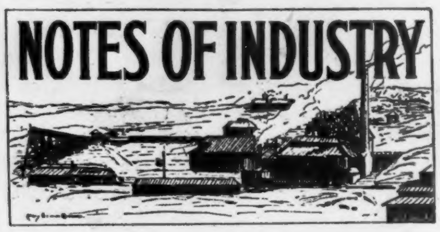
These carbonaceous deposits, when in sufficient quantities and in the presence of moisture and heat, are gas producers. The principal gas formed is carbon monoxide, which ignites at a temperature of 1,204° F. In the absence of the proper degree of heat for ignition, these gases are delivered to the workings; and, in the case of underground mining, carbon-monoxide poisoning of the workmen is not unlikely.

Neglect to clean intercoolers caused three of the accidents that were investigated. The hot air leaving the low-pressure cylinder carries a small amount of oil vapor in suspension, and this condenses when the air is cooled. The oil thus carried into the intercooler dries out and leaves a carbon deposit. When not cleaned out this deposit builds up and becomes a source of carbon-monoxide gas.

In five cases, the high-pressure discharge valves were found to be defective or broken, due to carbon deposits. The consequent leakage led to excessive temperatures, which made explosions possible. Hot air drawn back into the cylinder through a leaky discharge valve and recompressed is discharged at a higher temperature. It is evident that where the leak is great enough the temperature will build up to a dangerous point. And let us point out right here that the higher the speed of the compressor the less the effect of the leak.

Of the sixteen accidents, eleven occurred at the time of unloading, generally at the lunch hour. When unloading, there is a much reduced flow of air in the discharge passages. Under certain forms of governing of the compressor, or with leaky high-pressure discharge valves, this diminished flow of air will be of higher temperature, and favorable conditions for spontaneous combustion may thus be established. A protest is voiced against those systems of governing which depend on the throttling of the air inlet or on the return of the compressed product to be recompressed. Discharging into the atmosphere or the adoption of an increased clearance form of governing, it is pointed out, is preferable.

*Chief Inspector of Machinery for the Union of South Africa.



"The largest air station in the world" is to be established in an English city by the British Air Ministry, according to press announcements. The scheme, as reported, involves diverting a railroad and building a depot at the aerodrome—in short, there is to be a direct electric-train service between the air station and London. Huge steel hangars are to be erected; a hotel for travelers is to be constructed; and custom sheds and bonded warehouses are to be built for the convenience of the passengers.

A big water-power project has been started in North Wales that involves the construction of 600 miles of transmission lines for the purpose of carrying electric current over the whole of North Wales and a part of Cheshire.

It is generally conceded that ice cream was first made in Italy at about the time America was discovered but that it was left to the United States to develop the industry on a great scale.

According to a report of the American Consul at Prague, three dams are to be built on the Thaya River, near the Austrian border, for development of large blocks of hydro-electric power. The first dam will be situated between Bitov and Vranov, forming a basin to have a capacity of 236,500,000 cubic yards; the second near Podmole, creating a reservoir to hold 21,325,000 cubic yards; and the third at Znojmo, to impound 9,150,000 cubic yards of water. It is stated that these contemplated dams on the Thaya will be the largest in Central Europe.

The Hawaiian Islands are in many ways better off today than they were at any time since becoming United States territory, owing to the growing of more diversified crops, such as pineapples, coffee, bananas, and vegetables. The pineapple pack during 1923 is estimated at 5,500,000 cases of 24 cans each, valued at approximately $28,875,000. The development of this industry can be gaged somewhat from the fact that the total exports of pineapples from the islands during 1903 were worth only $7,500. The sugar crop for 1923 is estimated at 524,000 tons which, according to the annual report of the Governor of Hawaii, has a value of $62,880,000.

California sunshine for the drying of prunes is fast being supplanted by mechanical means of dehydration. More than 100 new dehydrators were erected in that state in 1923, and they handled one-fifth of the total prune crop. Experts from the University of California predict that eventually all prunes will be dried by artificial methods inasmuch as they produce not only a superior product but they do their work much quicker than the sunshine and the free air.

Homes and factories in the United States consumed 370,000,000,000 cubic feet of manufactured gas in 1923. This total establishes a record for the nation and marks an increase of about 20 per cent. over 1922, the previous high-record year.

Under the general supervision of the Department of Commerce and a special advisory committee, a more or less elaborate survey of the properties and uses of cement and concrete is to be made. The employment of cement in the construction of roads, bridges, buildings, etc., is now so extensive and diversified that the intelligent and appropriate use of the material has become a matter of great economic interest.

Professor Moss of the University of Birmingham, coöperating with Doctor Haldene, has made a study of the effects of chloride elimination through excessive sweating while working at high temperatures. He asserts that the addition of sodium and potassium chlorides to drinking water materially lessens muscular fatigue and prevents miners' cramps.

An experiment station, provided for by the Missouri legislature, has been completed on the campus of the Missouri School of Mines and Metallurgy, at Rolla, Mo. The building is a substantial one, containing offices, laboratories with suitable equipment, etc. The station is to specialize in zinc and lead, but will also take up the question of mine drill steels and of oil-well-drilling equipment.

New York, thanks to the Niagara, still leads in the development of water power, having a total output of approximately 1,300,000 H.P. California is a close second, with something over 1,100,000 H.P.; Washington is third, with 454,000; Maine holds fourth place with not quite 450,000; and Montana comes fifth, with 344,000 H.P.

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